Final Report

Toxic Air Contaminant Emission Inventory and Air Dispersion Modeling Report for the Mira Loma Auto Facility, Mira Loma, California

prepared for:

Union Pacific Railroad Company

January 2007

prepared by:

Sierra Research, Inc.
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SUMMARY

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory and air dispersion modeling analysis for the Mira Loma Auto Facility (Yard) in Mira Loma, California. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, area, and portable sources at the Yard. The inventory has been prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

The Mira Loma Auto Facility is an automobile distribution center. New automobiles are delivered to the Yard by train, where they are unloaded and sorted. The autos are then loaded onto car carrier trucks for distribution to local auto retailers. Activities at the Yard include receiving inbound rail cars, switching cars, loading and unloading automobiles, departing outbound rail cars, and storing automobiles. Facilities within the Yard include classification tracks, a gate complex for inbound and outbound truck traffic, loading and unloading tracks, and various buildings and facilities supporting railroad and contractor operations. UPRR also leases space at the Mira Loma yard to two contractors: Progress Rail and Inter-Rail Transport (IRT). Progress Rail's main activity is the repair of damaged rail cars. IRT crews unload and park the new automobiles arriving at the Yard. Across the main line and just north of the Yard is the Calpro facility. Calpro is a railcar repair service. The Calpro facility is not part of the Yard. However, locomotive emissions from pushing railcars into the Calpro facility have been included in the emission inventory for the Mira Loma Yard. Other emissions from the Calpro facility are not included in the Mira Loma Yard emissions inventory.

The Mira Loma facility operates 24 hours per day, 365 days per year. Emission sources include, but are not limited to, fuel storage tanks, Diesel-fueled shuttle vans, Diesel-fueled trucks, forklifts, portable Diesel-fueled air compressors, automobile unloading ramps, and locomotives. Emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year.

An air dispersion modeling analysis was also conducted for the Mira Loma Auto Facility. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations surrounding the Yard. Emission sources included in the modeling analysis were locomotives, heavy-heavy duty (HHD) Diesel-fueled trucks, Diesel-fueled forklifts, and the gasoline-fueled ramps. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and meteorological data from the Ontario International Airport. The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

Toxic Air Contaminant Emission Inventory
and Air Dispersion Modeling Report
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Mira Loma Auto Facility
Mira Loma, California

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Toxic Air Contaminant Emission Inventory and Air Dispersion Modeling Report for the Mira Loma Auto Facility Mira Loma, California

PART I. INTRODUCTION

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory for the Mira Loma Auto Facility Yard (Yard) in Mira Loma, California. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yard. Both source-specific and facility-wide emission estimates are shown. Locomotive emissions associated with pushing railcars into the adjacent Calpro facility have also been included in the inventory. The inventory has been prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and the *Emission Inventory Protocol*, which UPRR submitted to CARB in May 2006. Emissions have been calculated for the baseline year of 2005.

An air dispersion modeling analysis was also conducted for the Mira Loma Auto Facility. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations surrounding the Yard. Emission sources included in the modeling analysis were locomotives, heavy-heavy duty (HHD) Diesel-fueled trucks, Diesel-fueled forklifts, and the gasoline-fueled ramps. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and meteorological data from the Ontario International Airport. The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

PART II. FACILITY DESCRIPTION

A. Facility Name and Address

Union Pacific Railroad Company
Mira Loma Auto Facility
4500 Etiwanda Avenue
Mira Loma, CA 91752

B. Facility Contact Information

Brock Nelson
Director of Environmental Operations – West
Union Pacific Railroad Company
10031 Foothills Boulevard
Roseville, CA 95747
Phone: (916) 789-6370
Fax: (402) 233-3162
banelson@up.com

C. Main Purpose of the Facility

The Mira Loma Yard is an automobile distribution center. New automobiles are delivered to the Yard by train, where they are unloaded and sorted. The autos are then loaded onto car carrier trucks for distribution to local auto retailers.

D. Type of Operations Performed at the Facility

Activities at the Yard include receiving inbound rail cars, switching cars, loading and unloading automobiles, departing outbound rail cars, and storing automobiles. Facilities within the Yard include classification tracks, a gate complex for inbound and outbound truck traffic, loading and unloading tracks, and various buildings and facilities supporting railroad and contractor operations.

UPRR leases space at the Mira Loma Yard to two contractors: Progress Rail and Inter-Rail Transport (IRT). Progress Rail's main activity is the repair of damaged rail cars. IRT crews unload and park the new automobiles arriving at the yard.

E. Facility Operating Schedule

The facility operates 24 hours per day, 365 days per year.

F. General Land Use Surrounding the Facility

The land use surrounding the facility within 1,000 feet is industrial-commercial, with the nearest residence being approximately 1,500 feet south of the Galena Street gate. Additional residential areas are located beyond 2,000 feet to the north and south of the facility. There is also a junior high school approximately 500 feet south of the Galena Street entrance to the Yard. The locations of these and other specific receptors are further discussed in Part IX.

PART III. MAP AND FACILITY PLOT PLAN

Figure 1
Location Map

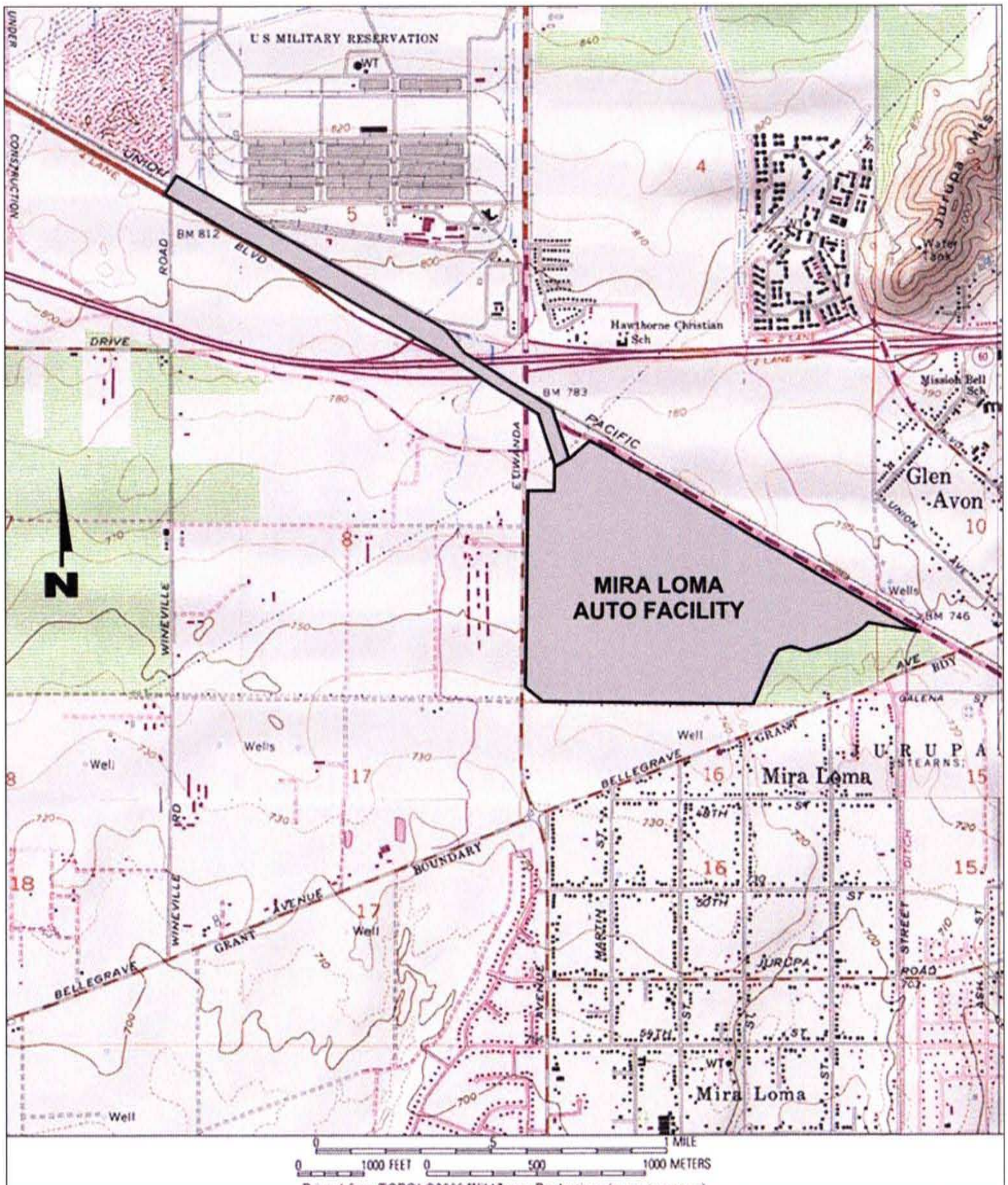
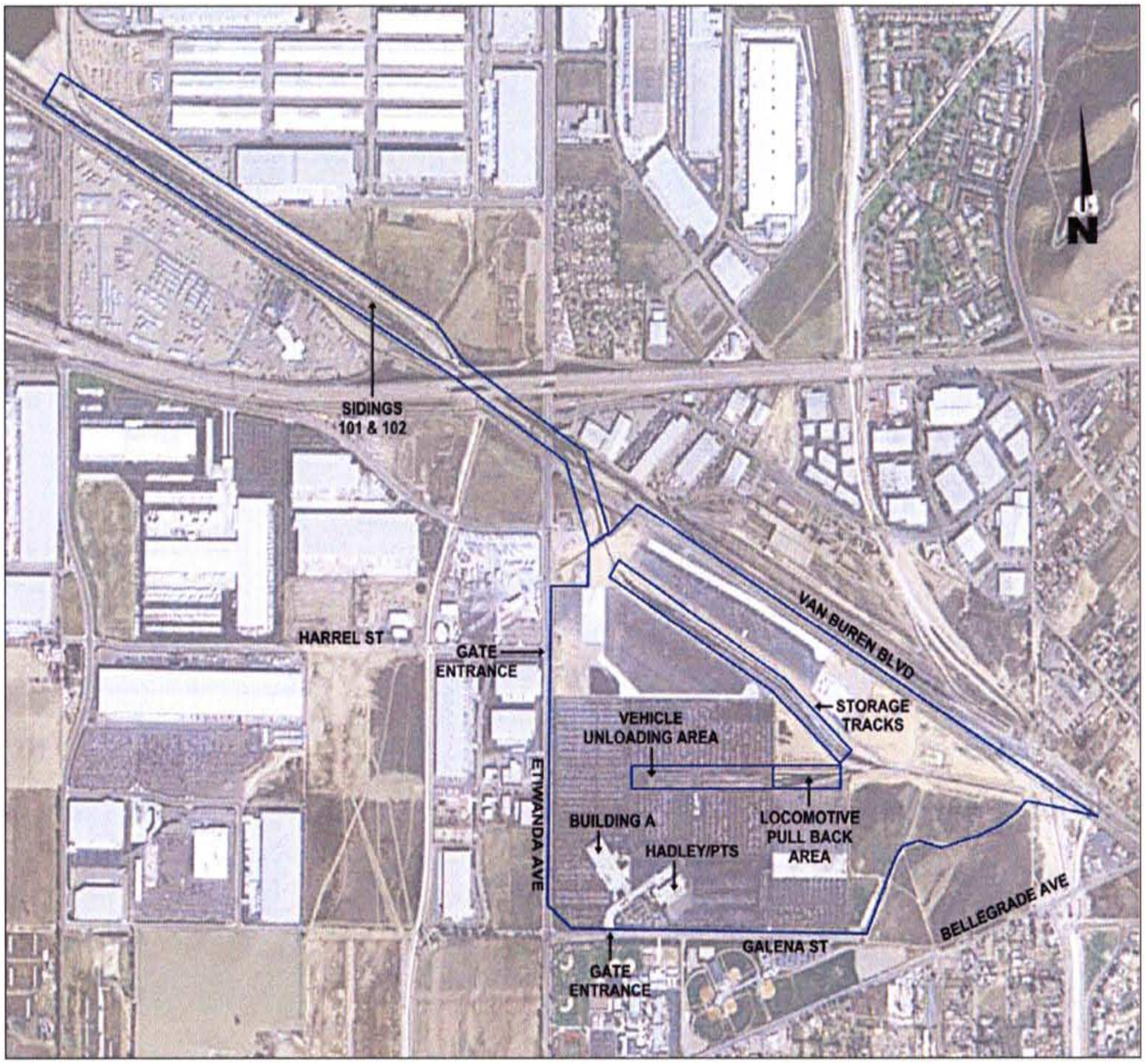


Figure 2
Mira Loma Auto Facility Layout



PART IV. COVERED SOURCES

This emission inventory quantifies toxic air contaminant (TAC) emissions from the stationary, mobile, and portable sources located or operating at the Mira Loma Auto Facility. Sources include, but are not limited to, fuel storage tanks, Diesel-fueled shuttle vans, Diesel-fueled trucks, forklifts, portable Diesel-fueled air compressors, automobile unloading ramps, and locomotives. A site-specific equipment inventory is included in Part V below.

Per the UPRR *Emission Inventory Protocol,* stationary point and area sources that are exempt from local air district rules have been identified but not included in the detailed emission inventory. Also, de minimis sources, based on weighted risk, have been identified in the inventory but are not further discussed or included in the modeling analysis. De minimis sources are the individual sources that represent less than 3 percent of the facility-total weighted-average site health risk (determined separately for cancer risk and non-cancer chronic health hazard). Total exclusions for all de minimis sources did not exceed 10 percent of the facility-total weighted-average site cancer risk or chronic health hazard. De minimis sources are further discussed in Part VIII of this report.

PART V. SITE-SPECIFIC EQUIPMENT INVENTORY

As discussed in Section IV above, there are a number of mobile, stationary, and portable emissions sources operating at the Mira Loma Auto Facility. The mobile sources include locomotives, heavy-heavy duty (HHD) Diesel-fueled trucks, Diesel-fueled shuttle vans, Diesel-fueled forklifts, and the new vehicles being delivered to the Yard. Other emission sources at the Yard also include fuel storage tanks and portable equipment, such as, air compressors and ramps used to load and/or unload automobiles from rail cars. Each source group is further discussed below.

A. Locomotives

Locomotive activities at the Yard are of two types: those working inside the facility to allow unloading of automobiles from rail cars; and those working outside the facility that pull trains to, from, or past the Yard. Within the Yard itself during 2005, rail operations were conducted using medium horsepower locomotives. Typically, this work was carried out by two [redacted] or [redacted] locomotives. Outside the yard, there are through trains that pass by on the main line, while auto and other trains terminate at or originate from sidings to the northwest of the Yard. The locomotives used to pull trains are referred to as "road power," and the group of locomotives pulling a single train is referred to as a "consist." Table 1 provides the number of locomotives in operation (arrivals, departures, and through traffic) at the yard during 2005 by locomotive model group and type of train. Through trains use the main line passing by the Yard. Auto trains and other trains enter and depart from Sidings 101 and 102 to the north of Mission Boulevard and the main line, and west of Etiwanda Avenue. Power moves are trains with locomotives but no attached railcars, whose objective is to either move locomotives to locations where they are needed, or to take malfunctioning units to service facilities.

Table 1 Equipment Specifications for Locomotives (Road Power) Mira Loma Auto Facility						
	Train Type[1]					
	Through Trains and Through Power Moves	Auto Trains		Other Trains		
Locomotive Model Group		Arriving	Departing	Arriving	Departing	Power Moves
Switch[2]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
GP3x	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
GP4x	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
GP50	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
GP60	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SD7x	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SD90	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Dash7	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Dash8	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Dash9	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
C60A	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Unknown	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Notes:
1. Includes all locomotives identified on an arriving, a departing, or a through train, including both working and non-working units.
2. Does not include switcher locomotives used for yard operations.

B. <u>HHD Diesel-Fueled Trucks</u>

Trucking companies and independent truck drivers haul the new vehicles from the Yard to local auto retailers. Hadley/PTS and Pacific Motor Trucking Company (PMT) are the primary auto haulers operating at the Yard. Truck fleet specific data for the smaller companies and independent drivers were not readily available. Therefore, it was assumed, for emission calculation purposes, that the fleet was composed entirely of Hadley/PTS and PMT trucks. The fleet distribution for the HHD Diesel-fueled trucks operating at the Yard is shown in Table 2.

Table 2
Fleet Distribution for HHD Diesel-Fueled Trucks
Mira Loma Auto Facility

Model Year	Owner	Number of Vehicles
[redacted]	Hadley/PTS	18
	PMT	19
[redacted]	PMT	32
[redacted]	PMT	15
[redacted]	PMT	17
[redacted]	Hadley/PTS	30
	PMT	14
[redacted]	Hadley/PTS	8
	PMT	8
[redacted]	Hadley/PTS	40
[redacted]	Hadley/PTS	20
	PMT	10
[redacted]	Hadley/PTS	20
	PMT	45
[redacted]	PMT	14
[redacted]	PMT	1
Total		311

Notes:
1. Model year distribution provided by Tom Colfield of PTS/Hadley and John O'Dwyer of PMT.

C. Shuttle Vans

Inter-Rail Transport (IRT) provides crews to unload and park the new automobiles arriving at the Yard. IRT uses two Diesel-fueled vans to transport the crews throughout the Yard. Table 3 shows the equipment specifications for the IRT's Diesel-fueled shuttle vans.

Table 3 Equipment Specifications for Shuttle Vans Mira Loma Auto Facility				
Owner	Equipment Type	Make/Model	Model Year	Vehicle Class
IRT[1]	Shuttle Van	[redacted]	[redacted]	LHDT1
IRT[1]	Shuttle Van	[redacted]	[redacted]	LHDT1

Notes:
1. Information provided by John Masters of IRT.

D. <u>Forklifts</u>

Progress Rail repairs damaged railcars at the Yard. They use forklifts and other equipment to complete the necessary repairs. Table 4 shows the equipment specifications for the Progress Rail's Diesel-fueled forklifts.

Table 4 Equipment Specifications for Forklifts Mira Loma Auto Facility				
Owner	Equipment Type	Make/Model	Model Year	Rated Capacity (hp)
Progress Rail[1]	Forklift	[redacted]	[redacted]	62
Progress Rail[1]	Forklift	[redacted]	[redacted]	84
Progress Rail[1]	Forklift	[redacted]	[redacted]	84

Notes:
1. Information provided by Frank Dominguez and Jesse Collett of Progress Rail.

E. <u>New Vehicles Arriving at the Yard</u>

Emissions from the unloading and sorting of the new vehicles arriving at the Yard are also included in the inventory. Based on interviews with the UPRR facility manager, it was assumed that the vehicles are gasoline-fueled passenger cars and light duty trucks. A total of [redacted] new vehicles were unloaded at the Yard in 2005.

F. Tanks

The only stationary emission sources at the Yard are the fuel storage tanks that are owned and operated by Progress Rail. Table 5 provides detailed information for all storage tanks located at the facility.

Table 5
Storage Tank Specifications
Mira Loma Auto Facility

Owner	Material Stored	Tank Capacity (gallons)
Progress Rail	Gasoline	240
Progress Rail	Gasoline	240
Progress Rail	Diesel	240

Notes:
1. Tank information provided by Frank Dominguez of Progress Rail.
2. Two additional 10,000-gallon Diesel-fuel storage tanks were installed in 2006 by PMT/Hadley. These tanks will not be included in the emission inventory or modeling analysis because they were installed after the baseline year.

As shown in Table 4, the capacity of each tank is less than 251 gallons; therefore, the tanks are exempt from South Coast Air Quality Management District (SCAQMD) permitting requirements per Rule 219(m)(9). Since the storage tanks are exempt from local air district rules, the emissions from the tanks will not be included in this inventory or the dispersion modeling analysis, consistent with the UPRR inventory protocol.

G. Air Compressors

Portable equipment operating at the Yard includes three (3) portable Diesel-fueled air compressors and ten (10) portable gasoline-fueled auto loading/unloading ramps. Equipment specifications for the air compressors are shown in Table 6.

Table 6 Equipment Specifications for Air Compressors Mira Loma Auto Facility				
Owner	Equipment Type	Number of Units	Fuel Type	Rated Capacity (hp)
Progress Rail[1,2]	Air Compressor	2	Diesel	49
Progress Rail[1]	Air Compressor	1	Diesel	125

Notes:
1. Information provided by Frank Dominguez and Jesse Collett of Progress Rail.
2. Exempt from SCAQMD permitting requirements per Rule 219(b)(1).

As shown in Table 6 above, Progress Rail operates two air compressors rated at 49 horsepower each. Internal combustion engines with a rated capacity of 50 brake horsepower or less are exempt from permitting requirements by SCAQMD Rule 219(b)(1). Therefore, these units are exempt from SCAQMD permitting requirements. Since these units are exempt from local air district rules, the emissions from these air compressors will not be included in this inventory nor in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

H. Ramps

IRT operates ten (10) gasoline-fueled ramps, which are used to unload new autos arriving at the Yard from the railcars. The equipment specifications for the ramps are shown in Table 7.

Table 7 Equipment Specifications for Ramps Mira Loma Auto Facility				
Owner	Equipment Type	Number of Units	Fuel Type	Rated Capacity (hp)
IRT[1]	Ramp	[redacted]	Gasoline	300
IRT[1]	Ramp	[redacted]	Gasoline	125

Notes:
1. Information provided by John Masters of Inter-Rail Transport.

PART VI. ACTIVITY DATA

Emissions from mobile sources are based on the number and type of equipment, equipment size, load factor, and operation during the baseline year of 2005. Since fuel consumption data were not available, default load factors from the OFFROAD2006 model and operating data were used for emission calculations. For sources where operating data weren't available, an average operating mode (AOM) was developed based on employee interviews.

A. Locomotives

Locomotive emissions were based on the number, model distribution, and operating conditions (idling, throttle notch, and speeds of movements, etc). Table 8 summarizes the activity data for locomotives operating on trains at the Yard, including the number of trains and number of operating locomotives per consist, as well as their idle and operating time, and speed on arrival or departure. Arriving auto trains are pushed into the storage tracks on the northeast side of the Yard by their road power, usually immediately on arrival. Departing trains are pulled out of the facility into the siding by their road power and prepared for their actual departure. The road power for other arriving trains uses the sidings to drop their cars. For other departing trains, road power is connected to train segments and prepared for their actual departure from the sidings. Although power moves may have as many as 10 or more locomotives, typically only one or two locomotives are actually working. For emission calculations, power moves were assumed to have 1.5 working locomotives (except for power moves involving just one locomotive).[1] In addition to road power, two locomotives operate in the yard to pull sections of auto trains from the storage tracks and spot them in the auto unloading area, and subsequently reconnect these sections and push the empty autoracks back into the storage tracks for removal on departing trains. These two locomotives operate on two 11-hour shifts per day with ½ hour for lunch.

[1] UP personnel report that although the train data records for power moves may show all locomotives "working," in actuality all locomotives except for one at the front and rear end (and more commonly only one at the front end) are shut down as they are not needed to pull a train that consists only of locomotives. Assuming 1.5 working locomotives per power move may slightly overestimate the actual average number of working locomotives per power move.

The data in Table 8 reflect the number of operating locomotives; locomotives that are being transported, but are not under power, are not shown. Since the Mira Loma Yard receives loaded auto trains, and discharges empty autoracks, the quantity of horsepower required for outbound (empty) trains is substantially lower than the horsepower required for inbound trains. As a result, Table 8 reflects the fact that there are a greater number of operating locomotives inbound to the Mira Loma Yard than there are outbound. The difference represents locomotives transferred to other yards while not under power.

B. <u>HHD Diesel-Fueled Trucks</u>

Table 9 summarizes the activity data for HHD Diesel-fueled trucks operating at the Yard. In addition to the traveling emissions, an average idling time of [redacted] minutes per HHD truck trip was assumed, to account for emissions during truck queuing and staging. Based on personal observation of gate activities and data contained in the *Mira Loma Auto Facility Gate Relocation/Consolidation Study* (HDR Engineering, Inc., March 2006), the average queuing time for HHD trucks is less than [redacted] minutes per truck.

C. <u>Shuttle Vans</u>

As previously discussed, IRT uses two Diesel-fueled vans to transport the crews throughout the Yard. The activity data for the shuttle vans are summarized in Table 10.

D. <u>Forklifts</u>

Progress Rail uses three (3) forklifts while completing repairs to damaged railcars. The activity data for the forklifts is summarized in Table 11.

Table 8
Train Activity Summary
Mira Loma Auto Facility

Train Type	East Bound		West Bound		Arrival/Departing Speed (mph)	Idle Time (hrs)	Operating Time (hrs)
	No. of Trains	Locomotives per Consist	No. of Trains	Locomotives per Consist			
Through Trains	[redacted]	[redacted]	[redacted]	[redacted]	50	[redacted]	[redacted]
Auto Train Arrivals	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]
Auto Train Departures	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]
Other Arrivals	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]
Other Departures	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]
Other Arrivals & Departures	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]
Power Moves Through	[redacted]	[redacted]	[redacted]	[redacted]	50	[redacted]	[redacted]
Power Moves Arriving	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]
Power Moves Departing	[redacted]	[redacted]	[redacted]	[redacted]	10	[redacted]	[redacted]

Notes:
1. Data reflect the number of operating locomotives; locomotives that are being transported, but are not under power, are not shown.
2. In addition to the activities described above, two locomotives are used in Yard operations. These two locomotives operate on two 11-hour shifts per day with ½ hour for lunch.

Table 9 **Summary of HHD Diesel Truck Activity Data** **Mira Loma Auto Facility**				
Number of New Vehicles Hauled in 2005[1]	Avg. Number of New Vehicles per Truck[2]	Number of HHD Truck Trips in 2005	VMT per HHD Truck Trip (mi/trip)[3]	Annual VMT (mi/yr)
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Notes:

1. Data from the UPRR data report system and interviews with UPRR personnel
2. Average from the September 2005 gate release log provided by UPRR.
3. Engineering estimate based on observation of truck activity. Trip length was estimated from the most common areas of truck loading to the gates. Estimate was confirmed by discussions with UPRR personnel.

Table 10 **Activity Data for Shuttle Vans** **Mira Loma Auto Facility**					
Owner	Equipment Type	Make/Model	Model Year	Annual VMT (mi/yr)	Vehicle Class
IRT	Shuttle Van	[redacted]	[redacted]	15,000	LHDT1
IRT	Shuttle Van	[redacted]	[redacted]	15,000	LHDT1

Notes:

1. Annual VMT for the shuttle vans was estimated by John Masters of IRT.

Table 11 **Activity Data for Forklifts** **Mira Loma Auto Facility**				
Owner	Equipment Type	Make/Model	Model Year	Hours of Operation (hr/yr)
Progress Rail	Forklift	[redacted]	[redacted]	1,460
Progress Rail	Forklift	[redacted]	[redacted]	6,570
Progress Rail	Forklift	[redacted]	[redacted]	6,570

Notes:

1. Information provided by Frank Dominguez and Jesse Collett of Progress Rail

E. New Vehicles Arriving at the Yard

Table 12 shows the activity data for the new vehicles arriving at the Yard in 2005. New vehicles arriving at the Yard are driven off the rail cars, inventoried, and sorted. The vehicles are then parked and temporarily stored until they are loaded onto the HHD trucks for transport to the local auto dealers. It was assumed, based on observation of operations and discussions with UPRR personnel, that each new vehicle was driven [redacted] miles during the unloading and sorting process.

Table 12
Summary of New Vehicle Activity Data
Mira Loma Auto Facility

Number of New Vehicles Entering Yard in 2005[1]	VMT per Vehicle (mi/vehicle)[2]	Total Annual VMT (mi/yr)
[redacted]	[redacted]	351,227

Notes:
1. Information from the UPRR data reporting system and interviews with UPRR personnel.
2. Engineering estimate based on observation of vehicle unloading activities and interviews with UPRR personnel.

F. Air Compressors

There are three (3) Diesel-fueled air compressors used at the Yard. As previously discussed, two of the units are exempt and will not be included in this inventory, consistent with the UPRR inventory protocol. The activity data for the non-exempt air compressor is shown in Table 13.

Table 13 Activity Data for the Air Compressor Mira Loma Auto Facility				
Owner	Equipment Type	Number of Units	Fuel Type	Hours of Operation (hr/yr)
Progress Rail	Air Compressor	1	Diesel	1,460

Notes:
1. Information provided by Frank Dominguez of Progress Rail. There are 3 Diesel-fueled air compressors used at the facility, but 2 units are exempt from permitting requirements and therefore, are not included in the inventory, consistent with the UPRR inventory protocol. See Table 5.

G. Ramps

There at ten (10) gasoline-fueled ramps used to unload new vehicles from railcars. Per IRT personnel, each ramp operates 15 minutes per hour or 6 hours per day, 365 days per year. Not all of the ramps are operated simultaneously. The activity data for the ramps are summarized in Table 14.

Table 14 Activity Data for Ramps Mira Loma Auto Facility				
Owner	Equipment Type	Number of Units	Fuel Type	Hours of Operation (hr/yr/unit)
IRT[1]	Ramp – 300 hp	[redacted]	Gasoline	2,190
IRT[1]	Ramp – 125 hp	[redacted]	Gasoline	2,190

Notes:
1. Information provided by John Masters of Inter-Rail Transport.

PART VII. EMISSIONS

A. Calculation Methodology and Emission Factors

Emission calculations were based on the site-specific equipment inventory, equipment activity data, and the source-specific emission factors. The calculation methodology and emission factors for each specific source type are further discussed below. Emissions were calculated in accordance with CARB Guidelines (July 2006) and the UPRR *Emission Inventory Protocol* (May 2006).

1. Locomotives

Emissions were calculated for UPRR-owned and -operated locomotives, as well as "foreign" locomotives[2] operating in the rail yard, and through trains on the main line. Procedures for calculating emissions followed the methods described in Ireson et al. (2005).[3] A copy of Ireson et al is contained in Appendix A-6.

Emissions from locomotive activities were calculated based on the number of working locomotives, time spent in each notch setting, and locomotive model-group distributions, with model groups defined by manufacturer and engine type.[4] A separate calculation was performed for each type of locomotive activity, including line-haul or switcher locomotive operations, and consist movements. Speed, movement duration, and throttle notch values were obtained from UPRR for the Mira Loma Yard, and for different types of in-yard activities. Detailed counts of locomotive by model, tier, and train type are shown in Appendix A-1 and A-2. Maps detailing the principal locomotive routes at the Yard are contained in Appendix A-5.

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[2] Foreign locomotives are locomotives not owned by UPRR, including passenger trains and locomotives owned by other railroads that are brought onto the UPRR system via interchange.

[3] Ireson, R.G., M.J. Germer, L.A. Schmid (2005). "Development of Detailed Railyard Emissions to Capture Activity, Technology, and Operational Changes." Proceedings of the USEPA 14th Annual Emission Inventory Conference, *http://www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*, Las Vegas NV, April 14, 2006.

[4] Emission estimates are based on the total number of working locomotives. Therefore, the total number of locomotives used in the emission calculations, shown in Table 8, is slightly lower than the total number of locomotives counted as arriving, departing, or through trains (shown in Table 1). See Appendix A for detailed emission calculations.

estimated sulfur content of in-use fuels. Fuel sulfur content reportedly affects the emission rates for Diesel particulate matter from locomotives. The sulfur content in Diesel fuel varies with the type of fuel produced (e.g., California on-road fuel, 49-state off-road fuel, 49-state on-road fuel), the refinery configuration at which it is produced, the sulfur content of the crude oil being refined, and the extent to which it may be mixed with fuel from other sources during transport. As a result, it is extremely difficult to determine with precision the sulfur content of the fuel being used by any given locomotive at a specific time, and assumptions were made to estimate sulfur content for different types of activities.

To estimate the fuel sulfur content for UPRR locomotives in California during 2005, the following assumptions were made:

- "Captive" locomotives and consists in use on local trains (e.g., commuter rail) used only Diesel fuel produced in California.
- Trains arriving and terminating at California rail yards (with the exception of local trains) used fuel produced outside of California, and arrive with remaining fuel in their tanks at 10 percent of capacity.
- On arrival, consists were refueled with California Diesel fuel, resulting in a 90:10 mixture of California and non-California fuel, and this mixture is representative of fuel on departing trains as well as trains undergoing load testing (if conducted at a specific yard).
- The average composition of fuel used in through trains by-passing a yard, and in trains both arriving and departing from a yard on the same day is 50 percent California fuel and 50 percent non-California fuel.

In 2005, Chevron was Union Pacific Railroad's principal supplier of Diesel fuel in California. Chevron's California refineries produced only one grade ("low sulfur Diesel" or LSD) in 2005. Quarterly average sulfur content for these refineries ranged from 59 ppm to 400 ppm, with an average of 221 ppm (Hinckley, 2006). This value is assumed to be representative of California fuel used by UPRR. Non-California Diesel fuel for 2005 is assumed to have a sulfur content of 2,639 ppm. This is the estimated 49-state average fuel sulfur content used by the U.S. Environmental Protection Agency in its 2004 regulatory impact analysis in support of regulation of non-road Diesel engines (EPA, 2004).

To develop emission inventories for locomotive activity, an initial collection of locomotive model- and notch-specific emissions data was adjusted based on sulfur content. Although there is no official guidance available for calculating this effect, a draft CARB document provides equations to calculate the effect of sulfur content on DPM emission rates at specific throttle settings, and for 2-stroke and 4-stroke engines (Wong, undated). These equations can be used to calculate adjustment factors for different fuels as described in Appendix A-7. The adjustment factors are linear in sulfur content, allowing emission rates for a specific mixture of California and non-California fuels to be calculated as a weighted average of the emission rates for each of the fuels. Adjustment factors were developed and used to prepare tables of emission factors for two different fuel sulfur levels: 221 ppm for locomotives operated on California fuel; and 2,639 ppm for locomotives operating on non-California fuel. These results are shown in Tables 15 and 16. Sample emission calculations are shown in Appendix A-3 and A-4. The calculations of sulfur adjustments are shown in Appendix A-7.

2. HHD Diesel-Fueled Trucks

Emission estimates for the HHD Diesel-fueled trucks are based on the number of trucks by model year and annual VMT within the Yard. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. A fleet-weighted average emission factor for traveling emissions was calculated, based on the model year distribution provided by PMT and PTS/Hadley (see Table 2), using the EMFAC-WD 2006 model with the BURDEN output option. A fleet-weighted average emission factor for idling was calculated, based on the model year distribution provide by PMT and PTS/Hadley, using the EMFAC-WD 2006 model with the EMFAC output option. The emission factors for the HHD Diesel-fueled trucks are shown in

Table 17. Detailed emission factor derivation calculations and EMFAC-WD 2006 output are contained in Appendix B.

Table 15
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 221 PPM
Mira Loma Auto Facility

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	129.2	140.6	173.3	272.7	315.6	409.1	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	174.1	187.5	230.2	369.1	423.5	555.1	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	211.9	228.6	289.7	488.5	584.2	749.9	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	282.3	275.2	339.6	587.7	663.5	847.2	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	266.3	264.8	323.5	571.6	680.2	859.8	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	224.1	311.5	446.4	641.6	1029.9	1205.1	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	146.8	215.0	276.8	331.8	434.7	538.0	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	215.7	335.9	388.6	766.8	932.1	1009.6	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	205.3	261.7	376.5	631.4	716.4	774.0	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	254.4	265.7	289.0	488.2	614.7	643.0	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	239.5	374.7	484.1	291.5	236.1	852.4	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	306.9	292.4	297.5	255.3	249.0	307.7	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	248.7	261.6	294.1	318.5	347.1	450.7	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	187.7	258.0	332.5	373.2	359.5	517.0	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	195.7	235.4	552.7	489.3	449.6	415.1	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	259.5	342.2	380.4	443.5	402.7	570.0	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	259.8	325.7	363.6	356.7	379.7	445.1	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	237.2	208.9	247.7	265.5	168.6	265.7	GE[4] (UP7555)

Notes:
1. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by ARB and ENVIRON
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report "Emissions Measurments – Locomotives" by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON..

Table 16
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 2,639 PPM
Mira Loma Auto Facility

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	136.9	156.6	197.4	303.4	341.2	442.9	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	184.5	208.8	262.2	410.8	457.9	601.1	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	224.5	254.6	330.0	543.7	631.6	812.1	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	299.0	306.5	386.9	653.9	717.3	917.4	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	282.1	294.9	368.5	636.1	735.4	931.0	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	237.4	346.9	508.5	714.0	1113.4	1304.9	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	155.5	239.4	315.4	369.2	469.9	582.6	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	228.5	374.1	442.7	853.3	1007.8	1093.2	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	217.5	291.5	428.9	702.6	774.5	838.1	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	269.4	295.9	329.2	543.3	664.6	696.2	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	253.7	417.3	551.5	324.4	255.3	923.1	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	352.7	323.1	327.1	293.7	325.3	405.4	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	285.9	289.1	323.3	366.4	453.5	593.8	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	215.7	285.1	365.6	429.3	469.7	681.2	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	224.9	260.1	607.7	562.9	587.4	546.9	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	298.2	378.1	418.3	510.2	526.2	751.1	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	298.5	359.9	399.8	410.4	496.1	586.4	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	272.6	230.8	272.3	305.4	220.3	350.1	GE[4] (UP7555)

Notes:
1. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by ARB and ENVIRON
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report "Emissions Measurments – Locomotives" by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON..

Table 17 Emission Factors for HHD Diesel-Fueled Trucks Mira Loma Auto Facility					
	Fleet Weighted Emission Factors[3]				
Operating Mode	ROG	CO	NOx	DPM[4]	SOx
Traveling (g/mi)[1]	5.80	15.29	29.18	2.35	0.25
Idling (g/hr)[2]	12.71	49.55	108.83	2.01	0.57

Notes:
1. Emission factors calculated using the EMFAC-WD 2006 model with the BURDEN output option
2. Emission factors calculated using the EMFAC-WD 2006 model with the EMFAC output option.
3. See Table 2 for fleet distribution.
4. Diesel PM_{10} (DPM) is a TAC.

3. Shuttle Vans

Emission estimates for the Diesel-fueled shuttle vans are based on the model year of the van and the annual VMT within the Yard. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling for each mode. A vehicle-specific emission factor was calculated for each van using the EMFAC-WD 2006 model. Traveling exhaust emission factors were calculated using the BURDEN output option and idling emission factors were calculated using the EMFAC output option. The SOx running exhaust emission factor for the [redacted] model year van provided by the EMFAC model was zero. To be conservative the emission factor for the [redacted] model year van (0.04 g/mi) was also used for the [redacted] model year van. The emission factors for the shuttle vans are shown in Table 18. Detailed emission factor derivation calculations and EMFAC-WD 2006 output are contained in Appendix C.

4. Forklifts

Emissions from the forklifts were calculated using CARB's OFFROAD2006 model. The forklift emission factors are shown in Table 19. Detailed emission factor derivation calculations and OFFROAD2006 output are contained in Appendix D.

Table 18 Emission Factors for Diesel-Fueled Shuttle Vans Mira Loma Auto Facility						
	Model	Emission Factors				
Operating Mode	Year	ROG	CO	NOx	DPM	SOx
Traveling (g/mi)[1,2]	[redacted]	0.44	1.71	8.71	0.08	0.04
	[redacted]	0.24	1.57	6.05	0.12	0.04
Idling (g/hr)[3]	[redacted]	3.17	26.30	75.05	0.75	0.36
	[redacted]	3.17	26.30	75.05	0.75	0.35

Notes:
1. Emission factors calculated using the EMFAC-WD 2006 model with the BURDEN output option.
2. The SOx running exhaust emission factor for the [redacted] model year vehicle provided by the EMFAC model was zero. To be conservative the emission factor for the [redacted] model year vehicle (0.04 g/mi) was also used for the [redacted] model year vehicle.
3. Emission factors calculated using the EMFAC-WD 2006 model with the EMFAC output option.

Table 19 Emission Factors for Diesel-Fueled Forklifts Mira Loma Auto Facility						
		Exhaust and Crankcase Emission Factors (g/hp-hr)[1]				
Make/Model	Model Yr	VOC[2]	CO	NOx	DPM[3, 4]	SOx[4]
[redacted]	[redacted]	1.44	3.91	7.22	0.75	0.06
[redacted]	[redacted]	1.44	3.91	7.22	0.75	0.06
[redacted]	[redacted]	0.66	3.46	5.61	0.38	0.06

Notes:
1. Emission factors from CARB's OFFROAD2006 model.
2. VOC evaporative emissions are negligible.
3. Diesel PM_{10} (DPM) is a TAC.
4. Assumes a Diesel fuel sulfur content of 130 ppm.

5. New Vehicles

Emission estimates for the new vehicles entering the Yard are based on the number of new vehicles, 1 trip per vehicle (1 start and stop), and the amount of time the vehicles remain in the Yard. Based on interviews with UPRR personnel, it was assumed that all vehicles are model year 2005 gasoline-fueled passenger cars, light-duty trucks, and medium-duty vehicles. It was assumed that each vehicle made one trip of [redacted] miles in length at an average vehicle speed of 15 miles per hour and that each vehicle remained in the Yard for 1 day. The criteria pollutant emission factors, in grams per vehicle, for the new vehicles are shown in Table 20. Detailed emission factor derivation calculations and EMFAC-WD 2006 output are contained in Appendix E.

Table 20
Criteria Pollutant Emission Factors for New Vehicles
Mira Loma Auto Facility

Emission Factors (g/vehicle)				
ROG	CO	NOx	PM_{10}	SOx
0.071	1.466	0.113	0.014	0.003

Notes:
1. Emission factors calculated using the EMFAC-WD 2006 model.

CARB's speciation profile database was used to determine the fraction of each TAC in the total ROG emissions. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program have been included. The TAC emission factors for new vehicles are shown in Table 21. The relevant sections of the speciation profile database are included in Appendix E.

6. <u>Air Compressors</u>

Emission estimates for the Diesel-fueled air compressor are based on the model year, rated capacity, and annual hours of operation. A unit-specific emission factor was calculated for the air compressor using CARB's OFFROAD2006 model. The emission factors for the air compressor are shown in Table 22. Detailed emission factor derivation calculations and OFFROAD2006 output are contained in Appendix F.

7. <u>Ramps</u>

Emission estimates for the gasoline-fueled ramps are based on the model year, rated capacity, and annual hours of operation for each unit. A unit-specific emission factor was calculated for each ramp using CARB's OFFROAD2006 model. The criteria pollutant emission factors for the ramps are shown in Table 23. Detailed emission factor derivation calculations and OFFROAD2006 output are contained in Appendix G.

Table 21
TAC Emission Factors for New Vehicles
Mira Loma Auto Facility

CAS	Chemical Name	Organic Fraction of VOC (by weight)
95636	1,2,4-trimethylbenzene	0.0096
106990	1,3-butadiene	0.0055
540841	2,2,4-trimethylpentane	0.0231
75070	Acetaldehyde	0.0028
107028	Acrolein	0.0013
71432	Benzene	0.0247
4170303	Crotonaldehyde	0.0003
110827	Cyclohexane	0.0061
100414	Ethylbenzene	0.0105
74851	Ethylene	0.0636
50000	Formaldehyde	0.0158
78795	Isoprene	0.0014
98828	Cumene	0.0001
67561	Methyl Alcohol	0.0012
78933	Methyl Ethyl Ketone (MEK)	0.0002
108383	m-Xylene	0.0356
91203	Naphthalene	0.0005
110543	n-Hexane	0.0160
95476	o-Xylene	0.0124
115071	Propylene	0.0306
100425	Styrene	0.0012
108883	Toluene	0.0576
Total		**0.32**

Notes:

1. The organic fraction information is from CARB's SPECIATE database. Data are from the "Cat stabilzed exhaust 2005 SSD etoh 2% (MTBE phaseout)" option.
2. Emissions were calculated only for chemicals that were in both the SPECIATE database and the AB2588 list.

Table 22 **Emission Factors for Diesel-Fueled Air Compressors** **Mira Loma Auto Facility**					
Rated Capacity (hp)	Emission Factors (g/hp-hr)[1]				
	VOC[2]	CO	NOx	DPM[3,4]	SOx[4]
125	0.202	0.957	44.179	0.048	0.100

Notes:
1. Emission factors from CARB's OFFROAD2006 model.
2. VOC evaporative emissions are negligible.
3. Diesel PM_{10} (DPM) is a TAC.
4. Assumes a Diesel fuel sulfur content of 130 ppm.

Table 23 **Emission Factors for Gasoline-Fueled Ramps** **Mira Loma Auto Facility**								
Rated Capacity (hp)	Model Year	Exhaust and Crankcase Emission Factors (g/hp-hr)[1]					VOC Evaporative Emission Factors	
		VOC	CO	NOx	PM_{10}	SOx[2]	Part 1 (g/hr)	Part 2 (g/yr)
300	[redacted]	4.058	53.477	11.788	0.060	0.007	8.50	13.47
300	[redacted]	3.957	52.515	11.765	0.060	0.007	8.50	13.47
125	[redacted]	3.957	52.515	11.765	0.060	0.007	8.50	13.47

Notes:
1. Emission factors from CARB's OFFROAD2006 model.
2. Assumes a gasoline sulfur content of 15 ppm.

CARB's speciation profile database was used to determine the fraction of each TAC in the total VOC emissions. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program have been included. The TAC emission factors for ramps are shown in Table 24. The relevant sections of the SPECIATE database are included in Appendix G.

Table 24 **TAC Emission Factors for Gasoline-Fueled Ramps** **Mira Loma Auto Facility**		
CAS	Chemical Name	Organic Fraction of VOC (by weight)
95636	1,2,4-trimethylbenzene	0.0129
106990	1,3-butadiene	0.0083
540841	2,2,4-trimethylpentane	0.0204
75070	acetaldehyde	0.0098
107028	acrolein (2-propenal)	0.0018
71432	benzene	0.0338
4170303	crotonaldehyde	0.0013
110827	cyclohexane	0.0046
110838	cyclohexene	0.0007
100414	ethylbenzene	0.0154
74851	ethylene	0.0916
50000	formaldehyde	0.0300
78795	isoprene	0.0014
98828	isopropylbenzene (cumene)	0.0005
67561	methyl alcohol	0.0035
78933	methyl ethyl ketone (mek)	0.0006
108383	m-xylene	0.0456
91203	naphthalene	0.0013
110543	n-hexane	0.0134
95476	o-xylene	0.0159
123386	propionaldehyde	0.0013
115071	propylene	0.0502
100425	styrene	0.0013
108883	toluene	0.0696
Total		**0.44**

Notes:

1. The organic fraction information is from CARB's SPECIATE database. Data are from the "Non-cat stabilized exhaust 1996 SSD 2.0% etoh (MTBE phaseout)" option.
2. Emissions were calculated only for chemicals that were in both the SPECIATE database and the AB2588 list.

B. <u>TAC Emissions by Source Type</u>

TAC emission calculations for each source type were based on the site-specific equipment inventory (shown in Part V of this report), equipment activity data (shown in Part VI of this report), and the source-specific emission factors shown in Part VII.A above.

Emissions from locomotive operations were based on the emission factors shown in Tables 15 and 16, the number of events, the number of locomotives per consist, duration, and duty cycle of different types of activity. Table 25 shows the duty cycles assumed for different types of activities.

Table 25
Locomotive Duty Cycles
Mira Loma Auto Facility

Activity	Duty Cycle
Through train movement	N5 – 50%, N6- 50%
Movement in Sidings 101 and 102	N1 – 50%, N2- 50%
Yard operations[1]	Idle – 50%, N3- 20%, N4 – 20%, N5 – 10%

Notes:
1. See Part IV for a detailed discussion of activities and other assumptions.

For locomotive models and tiers for which specific emission factors were not available, the emissions for the next lower tier were used, or the next higher tier if no lower tier data were available. Emission factors for the "average locomotive" for different types of activity were developed from the emission factors and the actual locomotive model and technology distributions for that activity. Separate distributions were developed for six types of activity: east-bound through, west-bound through, auto trains, other trains, power moves, and yard operations. Table 26 shows the DPM emission estimates for the different types of activities.

The DPM emissions from Yard operations in 2005 are the predominant source of locomotive emissions during that period, which preceded full utilization of "Green Goat™" low-emission hybrid locomotives that substantially reduced emissions from these activities in 2006. Emissions from through trains are a relatively minor source at the Yard due to the limited number of trains passing this location ([redacted] trains in 2005).

Table 26 **DPM Emissions from Locomotives** **Mira Loma Auto Facility**	
Activity	DPM Emissions (tpy)
Through trains	0.017
Auto trains	1.268
Other trains	0.529
Power moves	0.231
Yard operations	2.380
Total	**4.426**

Notes:
1. See Table 1 for equipment specifications.
2. See Table 8 for activity data.
3. See Tables 15 and 16 for emission factors.
4. Emissions from yard operations are based on two locomotives operating on two 11-hour shifts per day with ½ hour for lunch, the duty cycle shown in Table 25, and the emission factors shown in Tables 15 and 16.
5. See Appendices A-3 and A-4 for detailed emission calculations. The calculations of sulfur adjustments are shown in Appendix A-7.

DPM emissions from HHD Diesel-fueled trucks are shown in Table 27. DPM emissions from shuttle vans and forklifts are shown in Tables 28 and 29, respectively. Table 30 summarizes the TAC emissions from the new vehicles arriving at the Yard. DPM emissions from the Diesel-fueled air compressor are shown in Table 31. TAC emissions from the portable ramps are shown in Tables 32. Detailed emission calculations for each source group are contained in Appendix H.

Table 27 **DPM Emissions from HHD Diesel-Fueled Trucks** **Mira Loma Auto Facility**			
	Emissions (tpy)		
Pollutant	Traveling Mode	Idling Mode	Total
DPM	0.182	0.022	0.204

Notes:
1. See Table 2 for equipment inventory.
2. See Table 9 for activity data.
3. See Table 17 for emission factors.

Table 28 **DPM Emissions from Diesel-Fueled Shuttle Vans** **Mira Loma Auto Facility**			
	Emissions (tpy)		
Model Year	Traveling Mode	Idling Mode	Total
[redacted]	0.001	0.0002	0.0012
[redacted]	0.002	0.0002	0.0022
Total	**0.003**	**0.0004**	**0.003**

Notes:
1. See Table 3 for equipment inventory.
2. See Table 10 for activity data.
3. See Table 18 for emission factors.

Table 29 **DPM Emissions from Diesel-Fueled Forklifts** **Mira Loma Auto Facility**		
Make/Model	Model Year	DPM Emissions (tpy)
[redacted]	[redacted]	0.023
[redacted]	[redacted]	0.137
[redacted]	[redacted]	0.070
Total		**0.230**

Notes:
1. See Table 4 for equipment inventory.
2. See Table 11 for activity data.
3. See Table 19 for emission factors.

Table 30 TAC Emissions from New Vehicles Mira Loma Auto Facility		
CAS	Chemical Name	Emissions (tpy)
95636	1,2,4-trimethylbenzene	5.29×10^{-4}
106990	1,3-butadiene	2.99×10^{-4}
540841	2,2,4-trimethylpentane	1.27×10^{-3}
75070	acetaldehyde	1.53×10^{-4}
107028	acrolein (2-propenal)	7.27×10^{-5}
71432	benzene	1.36×10^{-3}
4170303	crotonaldehyde	1.59×10^{-5}
110827	cyclohexane	3.37×10^{-4}
100414	ethylbenzene	5.76×10^{-4}
74851	ethylene	3.49×10^{-3}
50000	formaldehyde	8.67×10^{-4}
78795	isoprene	7.78×10^{-5}
98828	isopropylbenzene (cumene)	5.29×10^{-6}
67561	methyl alcohol	6.71×10^{-5}
78933	methyl ethyl ketone (mek) (2-butanone)	1.00×10^{-5}
108383	m-xylene	1.96×10^{-3}
91203	naphthalene	2.59×10^{-5}
110543	n-hexane	8.78×10^{-4}
95476	o-xylene	6.79×10^{-4}
115071	propylene	1.68×10^{-3}
100425	styrene	6.74×10^{-5}
108883	toluene	3.16×10^{-3}
Total		**0.018**

Notes:
1. See Part V for equipment specifications.
2. See Table 12 for equipment inventory and activity data.
3. See Table 21 for emission factors.

Table 31 DPM Emissions from Diesel-Fueled Air Compressor Mira Loma Auto Facility	
Rated Capacity (hp)	DPM Emissions (tpy)
125	0.005
Total	**0.005**

Notes:
1. See Table 6 for equipment inventory.
2. See Table 13 for activity data.
3. See Table 22 for emission factors.

Table 32 TAC Emissions from Gasoline-Fueled Ramps Mira Loma Auto Facility		
CAS	Chemical Name	Emissions (tpy)
95636	1,2,4-trimethylbenzene	0.155
106990	1,3-butadiene	0.100
540841	2,2,4-trimethylpentane	0.245
75070	acetaldehyde	0.117
107028	acrolein (2-propenal)	0.022
71432	benzene	0.406
4170303	crotonaldehyde	0.016
110827	cyclohexane	0.055
110838	cyclohexene	0.009
100414	ethylbenzene	0.185
74851	ethylene	1.100
50000	formaldehyde	0.361
78795	isoprene	0.017
98828	isopropylbenzene (cumene)	0.006
67561	methyl alcohol	0.042
78933	methyl ethyl ketone (mek)	0.007
108383	m-xylene	0.547
91203	naphthalene	0.016
110543	n-hexane	0.161
95476	o-xylene	0.191
123386	propionaldehyde	0.016
115071	propylene	0.603
100425	styrene	0.016
108883	toluene	0.835
Total		**5.23**

Notes:
1. See Table 7 for equipment inventory.
2. See Table 14 for activity data.
3. See Table 24 for emission factors.

C. Facility Total Emissions

Facility-wide DPM emissions are shown in Table 33. Other TAC emissions are summarized in Table 34.

Table 33 **Facility-Wide Diesel Particulate Emissions** **Mira Loma Auto Facility**	
Source	Emissions (tpy)
Locomotives[1]	4.426
HHD Diesel-Fueled Trucks[2]	0.204
Diesel-Fueled Forklifts[3]	0.230
Diesel-Fueled Shuttle Vans[4]	0.004
Diesel-Fueled Air Compressor[5]	0.005
Total	**4.867**

Notes:
1. See Table 26.
2. See Table 27.
3. See Table 29.
4. See Table 28.
5. See Table 31.

Table 34
Facility-Wide TAC Emissions (excluding DPM)
Mira Loma Auto Facility

CAS	Chemical Name	Emissions (tpy)		
		New Vehicles	Ramps	Total
95636	1,2,4-trimethylbenzene	5.29×10^{-4}	1.55×10^{-1}	1.55×10^{-1}
106990	1,3-butadiene	2.99×10^{-4}	1.00×10^{-1}	1.00×10^{-1}
540841	2,2,4-trimethylpentane	1.27×10^{-3}	2.45×10^{-1}	2.46×10^{-1}
75070	acetaldehyde	1.53×10^{-4}	1.17×10^{-1}	1.17×10^{-1}
107028	acrolein (2-propenal)	7.27×10^{-5}	2.21×10^{-2}	2.22×10^{-2}
71432	benzene	1.36×10^{-3}	4.06×10^{-1}	4.08×10^{-1}
4170303	crotonaldehyde	1.59×10^{-5}	1.60×10^{-2}	1.60×10^{-2}
110827	cyclohexane	6.14×10^{-3}	5.53×10^{-2}	6.15×10^{-2}
110838	cyclohexene	-	8.64×10^{-3}	8.64×10^{-3}
100414	ethylbenzene	1.05×10^{-2}	1.85×10^{-1}	1.95×10^{-1}
74851	ethylene	6.36×10^{-2}	1.10	1.16
50000	formaldehyde	1.58×10^{-2}	3.61×10^{-1}	3.77×10^{-1}
78795	isoprene	1.42×10^{-3}	1.72×10^{-2}	1.86×10^{-2}
98828	isopropylbenzene (cumene)	5.29×10^{-6}	6.12×10^{-3}	6.13×10^{-3}
67561	methyl alcohol	6.71×10^{-5}	4.21×10^{-2}	4.22×10^{-2}
78933	methyl ethyl ketone (mek) (2-butanone)	1.00×10^{-5}	7.32×10^{-3}	7.33×10^{-3}
108383	m-xylene	1.96×10^{-3}	5.47×10^{-1}	5.49×10^{-1}
91203	naphthalene	2.59×10^{-5}	1.60×10^{-2}	1.60×10^{-2}
110543	n-hexane	8.78×10^{-4}	1.61×10^{-1}	1.62×10^{-1}
95476	o-xylene	6.79×10^{-4}	1.91×10^{-1}	1.91×10^{-1}
123386	propionaldehyde	-	1.60×10^{-2}	1.60×10^{-2}
115071	propylene	1.68×10^{-3}	6.03×10^{-1}	6.04×10^{-1}
100425	styrene	6.74×10^{-5}	1.60×10^{-2}	1.60×10^{-2}
108883	toluene	3.16×10^{-3}	8.35×10^{-1}	8.38×10^{-1}
Total		$\mathbf{1.10 \times 10^{-1}}$	**5.23**	**5.34**

PART VIII: RISK SCREENING CALCULATIONS

As discussed in Part IV of this report and agreed upon with CARB, de minimis sources, based on weighted health risk, were identified in the inventory but are not further discussed or included in the modeling analysis. De minimis sources are the individual source categories that represent less than 3 percent of the facility-total weighted-average site health impacts (determined separately for cancer risk and non-cancer chronic health hazard). Total exclusions for all de minimis sources did not exceed 10 percent of the facility-total weighted-average site health impacts.

The OEHHA unit risk factor for each pollutant was multiplied by the annual emissions of that pollutant to generate a risk index value for each source. Each source-specific risk index was divided by the facility total risk index to get the fractional contribution to the total risk for each source. Table 35 summarizes the cancer risk, the non-cancer health hazard index, and the fractional contribution to the cancer risk and non-cancer chronic health hazard for each source. Detailed cancer risk and non-cancer health hazard index calculations are in Appendix I.

Table 35
Summary of Weighted Risk by Source Category
Mira Loma Auto Facility

Source	Cancer Risk		Non-Cancer Chronic Health Hazard	
	Risk Index Value	Percent of Total Risk	Health Hazard Index Value	Percent of Total Health Hazard
Locomotives	1.33×10^{-3}	88.97	2.21×10^{1}	0.59
HHD Diesel Trucks	6.11×10^{-5}	4.09	1.02	0.03
Forklifts	6.90×10^{-5}	4.62	1.15	0.03
Shuttle Vans	1.09×10^{-6}	0.07	1.81×10^{-2}	0.00
Air Compressor	1.38×10^{-6}	0.09	2.31×10^{-2}	0.00
Ramps	3.18×10^{-5}	2.13	3.74×10^{3}	99.35
New Vehicles	1.86×10^{-7}	0.01	1.57×10^{-9}	0.00
Total	$\mathbf{1.51 \times 10^{-3}}$	**100**	$\mathbf{3.76 \times 10^{3}}$	**100**

Sources that represent less than 3 percent each of the facility-total weighted-average cancer risk and non-cancer chronic risk, as shown in Table 35, are de minimis. Table 36 lists the de minimis sources for the Mira Loma Yard.

Table 36
Summary of De Minimis Sources
Mira Loma Auto Facility

De Minimis Sources for Cancer Risk	De Minimis Sources for Non-Cancer Chronic Health Hazard
Shuttle Vans Ramps New Vehicles Air Compressor	Shuttle Vans Air Compressor New Vehicles

Notes:

1. Sources that are de minimis for both cancer risk and non-cancer chronic health hazard will not be included in the dispersion modeling analysis.

Sources that are de minimis for both cancer risk and non-cancer chronic health hazard (i.e. shuttle vans, new vehicles, and air compressors) are not included in the dispersion modeling analysis.

PART IX: AIR DISPERSION MODELING

An air dispersion modeling analysis was conducted for the Mira Loma Yard. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations surrounding the Yard out to distances of approximately 6 miles. Air dispersion modeling was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006). Each aspect of the modeling is further described below.

A. Model Selection and Preparation

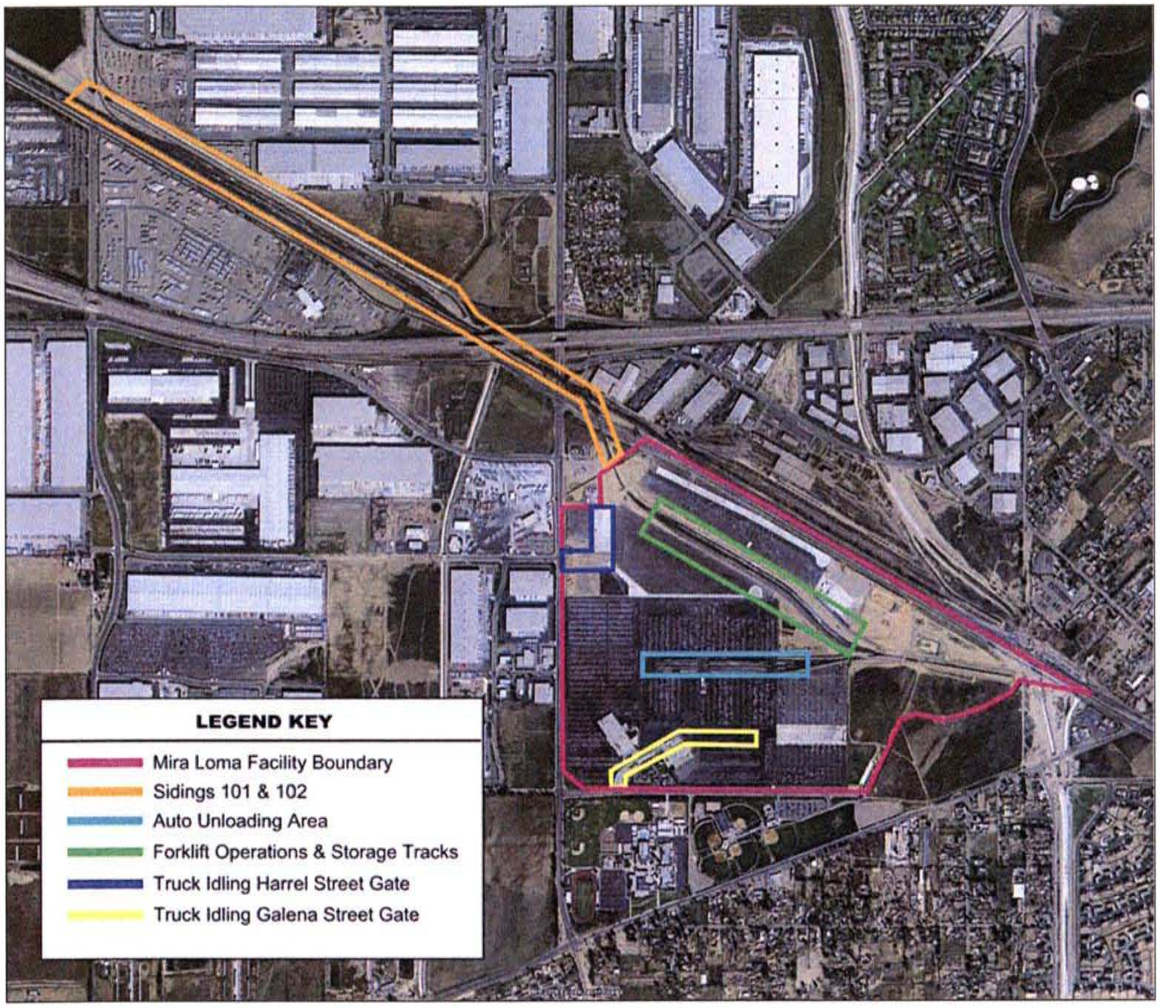
1. Modeled Sources and Source Treatment

As discussed in Part VIII, only sources that represent more than 3 percent of the facility-total weighted-average site health impacts (determined separately for cancer risk and non-cancer chronic health hazard) were included in the dispersion modeling analysis. Emissions from mobile sources and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Idling locomotives were simulated as a series of point sources within the areas where these events occur. The elevation for each source was interpolated from a 50 m grid of USGS terrain elevations. Table 37 shows the sources that were included in the modeling analysis and treatment used for each source. Assumptions used to spatially allocate emissions from locomotive operations within the Yard are included in Appendix A-4. Assumptions used to spatially allocate emissions from non-locomotive sources are contained in Appendix J.

Table 37 Treatment for Sources in Dispersion Modeling Analysis Mira Loma Auto Facility	
Source	Source Treatment
Locomotives (idling)	Point
Locomotives (traveling)	Volume
HHD Diesel Trucks (idling)	Volume
HHD Diesel Trucks (traveling)	Volume
Diesel-Fueled Forklifts (low level)	Volume
Ramps (low level)	Volume

Notes:
1. See Figure 3 for source locations.

Figure 3
Source Locators



2. Model Selection

Selection of air dispersion models depends on many factors, including the type of emissions source (point, line, or volume) and type of terrain surrounding the emission source. The USEPA-approved guideline air dispersion model, AERMOD, was selected for this project. AERMOD is recommended by EPA as the preferred air dispersion model, and is the recommended model in the CARB's *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006).

AERMOD is a steady-state,[6] multiple-source, Gaussian dispersion model designed for use with emission sources situated in terrain where ground elevations can exceed the release heights of the emission sources (i.e., complex terrain).[7] AERMOD was used with hourly wind speed, wind direction, temperature, and cloud cover data from the Ontario International Airport meteorological station. AERMOD used these parameters to select the appropriate dispersion coefficients.

Standard AERMOD control parameters were used, including stack-tip downwash, non-screening mode, non-flat terrain, and sequential meteorological data check. Following USEPA guidance, stack-tip downwash adjusted the effective stack height downward following the methods of Briggs (1972) for stack exit velocity less than 1.5 times the wind speed at stack top.

Two AERMET preprocessors (Stages 1 and 2, and Stage 3) were used to prepare meteorological data for use in AERMOD. Albedo and Bowen ratio[8] were estimated in multiple wind direction sectors surrounding the Yard, while surface roughness from

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[6] The term "steady-state" means that the model assumes no variability in meteorological parameters over a one-hour time period.

[7] Federal Register, November 9, 2005; Volume 70, Number 216, Pages 68218-68261.

[8] The albedo of a specified surface is the ratio of the radiative flux reflected from the surface to the radiative flux incident on the surface. Flux is the amount of energy per unit time incident upon or crossing a unit area of a defined flat plane. For example, the albedo for snow and ice varies from 80% to 85% and the albedo for bare ground from 10% to 20%. Bowen ratio is the ratio of heat energy used for sensible heating (conduction and convection) of the air above a specified surface to the heat energy used for latent heating (evaporation of water or sublimation of snow) at the surface. The Bowen ratio ranges from 0.1 for the ocean surface to more that 2.0 for deserts; negative values are also possible.

similar sectors around the meteorological monitoring site was used in the model. This separation was based on the fact that atmospheric turbulence induced by surface roughness around the meteorological monitoring tower affects the resulting wind speed profile used by AERMOD to represent conditions at the Yard, while the albedo and Bowen ratio around the Yard are more appropriate to characterize land use conditions surrounding the area being modeled.

As suggested by USEPA (2000), for purposes of determining albedo and Bowen ratio the surface characteristics were specified in sectors no smaller than a 30-degree arc. Specifying surface characteristics in narrower sectors becomes less meaningful because of expected wind direction variability during an hour, as well as the encroachment of characteristics from the adjacent sectors with a one-hour travel time. Use of weighted-average[9] characteristics by surface area within a 30-degree (or wider) sector made it possible to have a unique portion of the surface significantly influence the properties of the sector that it occupies. The length of the upwind fetch for defining the nature of the turbulent characteristics of the atmosphere in each sector surrounding the source location was 3 kilometers as recommended by Irwin (1978) and USEPA's *Guideline on Air Quality Models.*[10]

3. Modeling Inputs

Modeling was based on the annual average emissions for each source as discussed in Part VII.B above. Temporal and seasonal activity scalars were applied to locomotive activities, cargo handling equipment activities, and HHD truck operations. The following profiles were used in the modeling. See Appendix K for additional details.

- A seasonal/diurnal activity profiles was calculated for locomotive idling based on the number of arrivals and departures in each hour of the day and the number of arriving and departing trains in each season. Each hourly factor was based on the number of arrivals and departures in that hour, the number of arrivals in the

[9] Weighting was based on wind direction frequency, as determined from a wind rose.
[10] USEPA (1986), and published as Appendix W to 40 CFR Part 51 (as revised).

preceding two hours, and the number of departures in the following two hours. This approach captures the idling times for consists on arrival and departure. These factors were applied to consist idling for arriving and departing trains, and idling at the service track.

- A seasonal/diurnal activity profile was calculated for road power arrivals, departures, and other movements in Sidings 101 and 102 using the same approach as for idling. In this case, however, only the number of arriving and departing trains in a single hour was used for that hour's factor.
- In-yard switching operations were assumed to be uniform throughout the year, and neither diurnal or seasonal factors were applied.
- A diurnal activity profile for HHD truck activity was developed assuming uniform activity levels from 6 AM to 6 PM and from 6 PM to 6 AM, with 80 percent of total activity occurring during the day.
- The seasonal distribution for arriving and departing trains was applied to HHD truck activity at the facility.

The volume source release heights and vertical dispersion parameters (σ_z) were those used by CARB for the Truck Stop Scenario in Appendix VII of the Diesel Risk Reduction Plan for mobile vehicles and equipment other than locomotives. For locomotives, the release height and σ_z values used were those developed by CARB for daytime and nighttime locomotive movements in the Roseville Risk Assessment modeling. Stack parameters used to create the AERMOD input file for locomotive operations are shown in Table 38. Table 39 summarizes the modeling inputs used to create the AERMOD input file for each non-locomotive source at the Yard.

Table 38 Locomotive Modeling Inputs Mira Loma Auto Facility							
	Point/Idling Source Parameters				Volume Source Parameters		
Source	Stack Ht (m)	Stack Dia. (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y (m)	Release Ht (m)
Locomotives (idling and load tests)[1]							
Road power at all yards-SD7x [2]	4.6	0.625	3.1	364	-	-	-
Yard locomotives ML-GP60	4.6	0.625	3.1	362	-	-	-
Locomotives (traveling)[3]							
Day[4]	-	-	-	-	2.6	20-50	5.6
Night[4]	-	-	-	-	6.79	20-50	14.6

Notes:

1 Stack parameters for stationary locomotives taken from the CARB Roseville modeling.

2 Idling road power stack parameters are those of the most prevalent locomotive model (SD-7x).

3 All locomotive movements for road power and yard locomotives while working are the day and night volume source parameters for moving locomotives from the CARB Roseville modeling.

4 Lateral dispersion coefficient (σ_y) for moving locomotive volume sources was set to values between 20 and 50 m, depending on the spacing of sources in different areas of the yard and proximity to yard boundaries

Table 39 Non-Locomotive Modeling Inputs Mira Loma Auto Facility			
	Volume Source Parameters		
Source	σ_z (m)	σ_y (m)	Release Height (m)
HHD Diesel-fueled Trucks [1,2]	1.39	20-50	4.15
Forklifts [1,2]	1.39	20-50	4.15
Ramps [1,2]	1.39	20-50	4.15

Notes:

1. Low level sources treated as volume sources using the release height and vertical dispersion parameter (σ_z) from the CARB Diesel Risk Reduction Plan (Sept 13, 2000), Appendix VII, Table 2 (Truck stop scenario).
2. Low level source lateral dispersion parameter (σ_y) set to a value between 20 and 50 meters based on spacing between sources and proximity to the yard boundary.

4. Meteorological Data Selection

The Yard does not monitor meteorological variables on site. Data from the nearest National Weather Service monitoring site, Ontario International Airport (approximately 5.5 miles to the northwest of the Yard), were used for this project.

To the extent that airflow patterns are spatially variable due to elevated terrain and land-sea effects near the coast, judgment was exercised to select the monitoring stations that are most representative of conditions at the Mira Loma Yard.

Because rail yards, especially emissions from locomotives, tend to be aligned linearly along the main track routes, the directions of prevailing surface winds are important to achieve representativeness of model predictions in the near field. For longer transport distances (e.g., 1 to 10 km), surface winds were still the primary consideration, with atmospheric stability also playing an important role. Due to the relatively low release heights and limited plume rise of rail yard sources, modeled concentrations are relatively insensitive to mixing heights, temperatures, and vertical temperature and wind profiles.

The selection of Ontario for surface winds data was largely dependent on the limited availability of data from other stations for the same years for which upper air data were available. There are four SCAQMD surface stations in the general vicinity of the Yard for which historical (1981) data are available, but only in a form useable in AERMOD's predecessor, ISCST3.

AERMET, the meteorological preprocessor for AERMOD, required at a minimum data from one surface National Weather Service (NWS) station, Ontario International Airport for the Yard, and one upper air NWS station, Miramar Marine Corps Air Station in San Diego. Missing hourly surface data from Ontario International Airport were replaced by the last previous values available in the same dataset.

Eleven years worth of meteorological data from Ontario, for years 1990 through 2000, were processed with AERMET to assure that an adequate number of years of acceptable data completeness and quality would be available for AERMOD modeling. It is expected that year-to-year variability would not cause significant differences in the modeled health impacts, and hence would justify needing only to subject the full set of receptors to one year of meteorological data. The meteorological data from 1999 were selected for the rail yard dispersion modeling because it was one of the two years recorded after the anemometer height was adjusted, and it was the year with the most conservative (i.e., largest) distances of impact from a specified source.

5. Model Domain and Receptor Grids

A domain size of 20 km by 20 km with varying receptor spacing was used. Within 300 m of the facility, receptor spacing was 50 m. Between 300 and 600 m, and between 600 m and 1 km, receptor spacing was 100 m and 200 m, respectively. Receptors were spaced 500 m apart throughout the rest of the domain.

All receptors were identified by UTM coordinates. United States Geological Survey (USGS) 7.5 Minute digital elevation model (DEM) data were used to identify terrain heights at each receptor. Figures 4 and 5 show the outline of the Yard along with the coarse and fine receptor grids.

Sensitive receptors, consisting of hospitals, schools, day-care centers, and elder care facilities, within a 1-mile radius of the Yard, were identified. Table 40 lists the address, elevations, and UTM coordinates for each sensitive receptor. Figure 6 shows the outline of the Yard and the location of each sensitive receptor identified in Table 40.

Figure 4
Coarse Modeling Grid

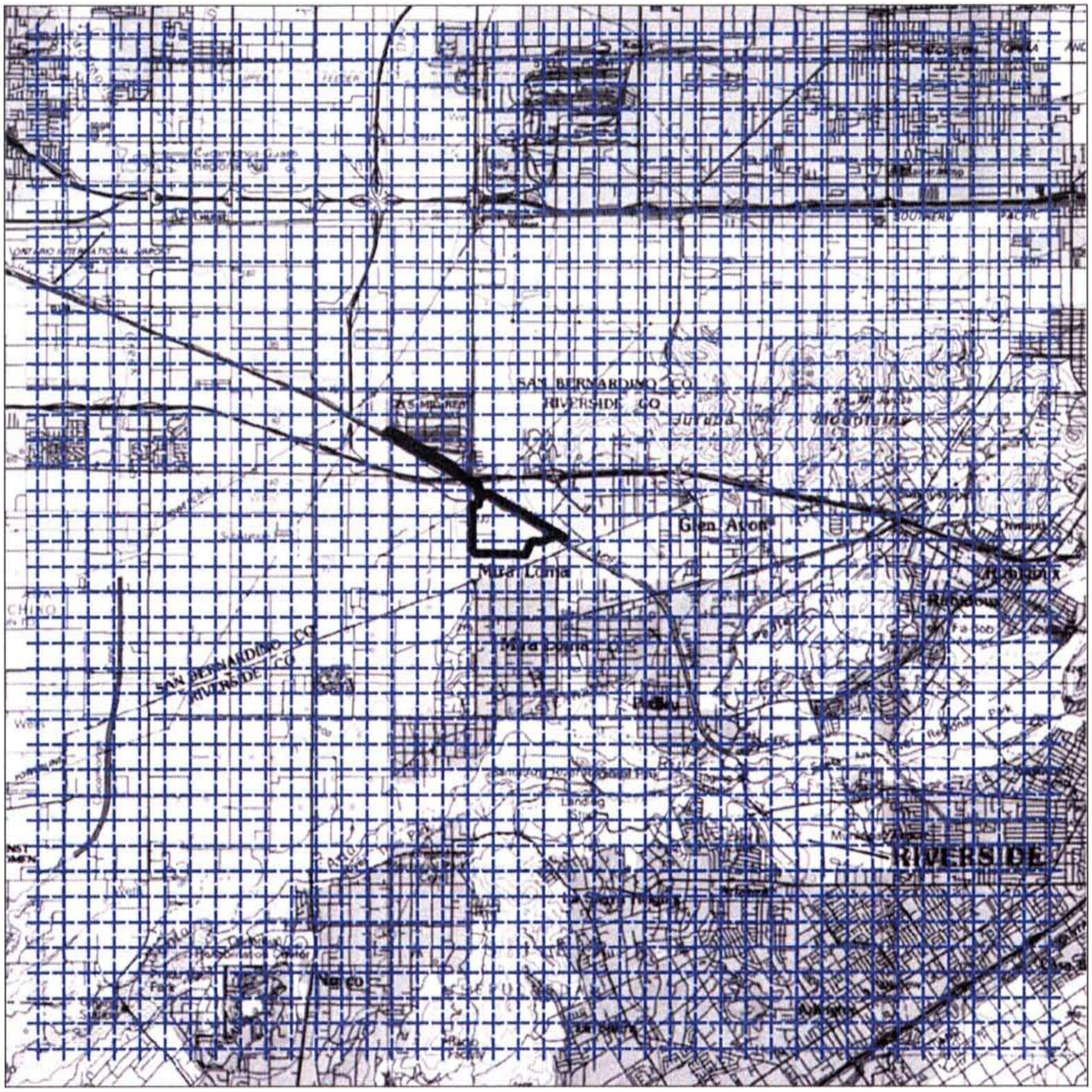


Figure 5
Fine Modeling Grid

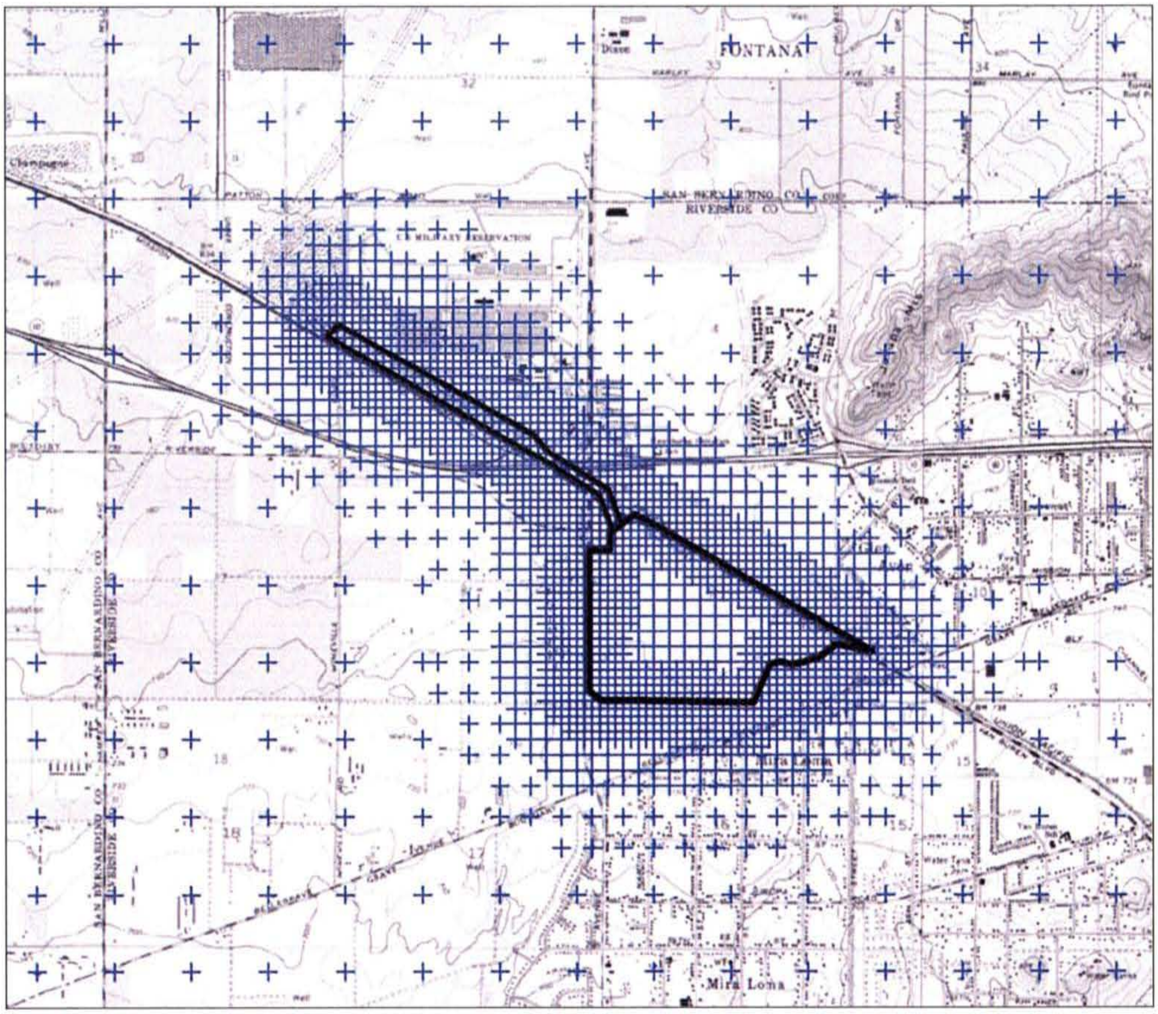


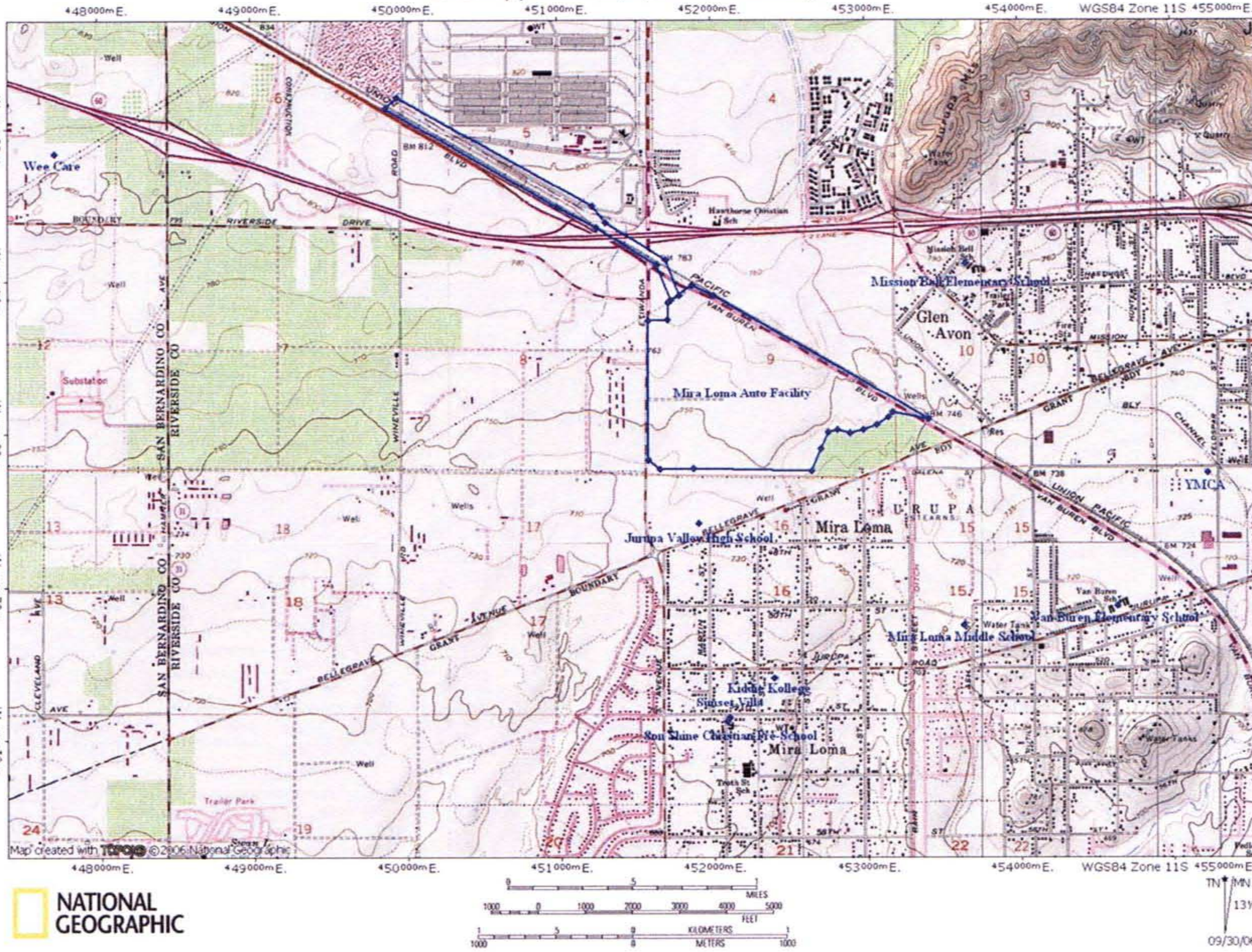
Table 40
Sensitive Receptor Locations
Mira Loma Auto Facility

Receptor	Address	Elevation (m)	UTM-E (m)	UTM-N (m)
Jurupa Valley High School	10551 Bellegrave Ave, Mira Loma, CA 91752	224	451903	3762401
Mira Loma Middle School	5051 Steve St, Riverside, CA 92509	221	453632	3761730
Van Buren Elementary	9501 Jurupa Road, Riverside, CA 92509	222	454637	3761846
Mission Bell Elementary	4020 Conning Street, Riverside, CA 92509	237	453655	3764087
Son Shine Christian Pre-School	5430 Ridgeview Ave, Mira Loma, CA 91752	216	452086	3761103
Y M C A	9254 Galena St, Riverside, CA 92509	223	455234	3762714
Kiddie Kollege	10558 Jurupa Rd, Mira Loma, CA 91752	217	452391	3761386
Wee Care	3876 Lytle Creek Loop, Ontario, CA 91761	245	447722	3764831
Sunset Villa	10650 54th St, Mira Loma, CA 91752	217	452102	3761126

Notes:
1. UTM Coordinates are in Zone 11, NAD 83.

Figure 6
Sensitive Receptors

TOPO! map printed on 09/30/06 from "MiraLoma.tpo"



6. Dispersion Coefficients

Dispersion coefficients are used in air dispersion models to reflect the land use over which the pollutants are transported. The area surrounding the Yard was divided into sectors to characterize the albedo and Bowen ratio. The area surrounding the Ontario International Airport meteorological monitoring station was similarly divided into sectors to characterize surface roughness. These parameters were provided along with the meteorological data to the AERMET software. The resulting meteorological input file allows AERMOD to select appropriate dispersion coefficients during its simulation of air dispersion. AERMOD also provides an urban input option to use the overall size of the Standard Metropolitan Statistical Area that contains the emission source (i.e., the Yard) in accounting for the urban heat island effect on the nocturnal convective boundary layer height. If the option is not selected, AERMOD defaults to rural dispersion coefficients. If the urban option is selected, but no surface roughness is specified (not to be confused with the surface roughness parameters already specified for sectors around the meteorological monitoring station and input to AERMET), AERMOD assigns a default "urban" surface roughness of 1 meter. For the Mira Loma Yard, AERMOD was run with the urban option. Based on CARB and USEPA guidance,[11] namely "*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source,*" the area encompassed by the surrounding County of Riverside was considered to determine the urban heat island effect on the nocturnal convective boundary layer height. The population of Riverside County[12] is approximately 1,545,000, and the surface roughness that characterizes this metropolitan area was set to 1 m. See Appendix L for additional discussion of this issue.

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[11] AERMOD Implementation Guide, September 27, 2005, http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf

[12] County of Riverside. http://www.city-data.com/county/Riverside_County-CA.html.

7. Building Downwash

Building downwash effects were considered for the Yard. Stack-tip downwash adjusted the effective stack height downward following the methods of Briggs (1972) when the stack exit velocity was less than 1.5 times the wind speed at stack top. The locomotives are the only structures in the Yard of sufficiently large size and close enough proximity to the modeled emission sources (i.e., their own stacks) to be entered into the Building Profile Input Program (BPIP) with one set of dimensions for a "standard" locomotive (24.2 m. long x 4.0 m. wide x 4.6 m. high).

B. Modeling Results

The AERMOD input and output files have been provided to CARB in an electronic format.

C. Demographic Data

Demographic data files have been provided to CARB in an electronic format. See Appendix M for a description of the data.

PART X: REFERENCES

Briggs, G.A. (1972). *Discussion on Chimney Plumes in Neutral and Stable Surroundings*. Atmos. Environ. 6:507-510.

CARB (2000). *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles.* (Available at *www.arb.ca.gov/diesel/documents/rrpapp.htm*)

CARB (2003). *Staff Report: Initial Statement of Reasons for Proposed Rule Making for the Airborne Toxic Control Measure for In-use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate.* (Available at *www.arb.ca.gov/regact/trude03/isor.pdf*)

CARB (2004). *Roseville Rail Yard Study.* (Available at *www.arb.ca.gov/diesel/documents/rrstudy/rrstudy101404.pdf*)

CARB (2006). *Rail Yard Emission Inventory Methodology.* (Available at *www.arb.ca.gov/railyard/hra/071806hra_eim.pdf*)

CARB (2006). *Health Risk Assessment Guidance for Rail Yards and Intermodal Facilities.* (Available at *www.arb.ca.gov/railyard/hra/071806hra_guideline.pdf*)

CARB (2006). *EMFAC-WD2006 Model.* (Available at *www.arb.ca.gov/msei/onroad/latest_version.htm*)

CARB (2006). *OFFROAD2006 Model.* (Available at *www.arb.ca.gov/msei/offroad/offroad.htm*)

Ireson, R.G., M.J. Germer, L.A. Schmid (2005). *Development of Detailed Rail yard Emissions to Capture Activity, Technology, and Operational Changes.* Proceedings of the USEPA 14th Annual Emission Inventory Conference, Las Vegas NV, April 14, 2006. (Available at *www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*)

Irwin, J.S. (1978). *Proposed Criteria for Selection of Urban Versus Rural Dispersion Coefficients*. Staff Report. Meteorology and Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC. (Air Docket Reference No. II-B-8 for the Fourth Conference on Air Quality Modeling).

Nappo, C. J. et al. (1982). *The Workshop on the Representativeness of Meteorological Observations*, June 1981, Boulder, CO. Bulletin Amer. Meteor. Soc., Vol. 63, No. 7, pp. 761-764. American Meteorological Society, Boston, MA.

USEPA (1986). *Guideline on Air Quality Models (Revised).* U.S. EPA-45/2-78-027R, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA (1987a). *Supplement A to the Guideline on Air Quality Models (Revised).* Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA (1987b). *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD).* Office of Air Quality Planning and Standards, and Office of Research and Development, Research Triangle Park, NC.

USEPA (1995). *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.* (Available at www.epa.gov/ttn/chief/ap42/)

USEPA (1998). *Locomotive Emission Standards -- Regulatory Support Document.* (Available at *www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

USEPA (2000). *Meteorological Monitoring Guidance for Regulatory Modeling Applications.* Publication No. EPA-454/R-99-005. Office of Air Quality Planning & Standards, Research Triangle Park, NC. (PB 2001-103606) (Available at *www.epa.gov/scram001/*)

USEPA (2004). *Final Regulatory Impact Analysis: Control of Emissions from Non-Road Diesel Engines.* U.S. EPA 420-R-04-007. Office of Air Quality Planning and Standards, Assessment and Standards Division, Research Triangle Park, NC.

USEPA (2005). *AERMOD Implementation Guide.* (Available at *www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf*).

Wong, W (undated). *Changes to the Locomotive Inventory.* Draft OFFROAD Modeling Change Technical Memo.

APPENDIX A

LOCOMOTIVE DATA

APPENDIX A-1

LOCOMOTIVE MODEL, TIER, AND AUTO-START/STOP TECHNOLOGY FREQUENCY BY TRAIN TYPE

Appendix A1 –Locomotive Model, Tier, and Auto-Start/Stop
Technology Frequency by Train Type

Through Trains
# of EB arrivals

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N												
N	Y												
0	N												
0	Y												
1	N												
1	Y												
2	N												
2	Y												

# of EB departures

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N												
N	Y												
0	N												
0	Y												
1	N												
1	Y												
2	N												
2	Y												

Through Trains (cont.)

# of WB arrivals

[redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

# of WB departures

[redacted]

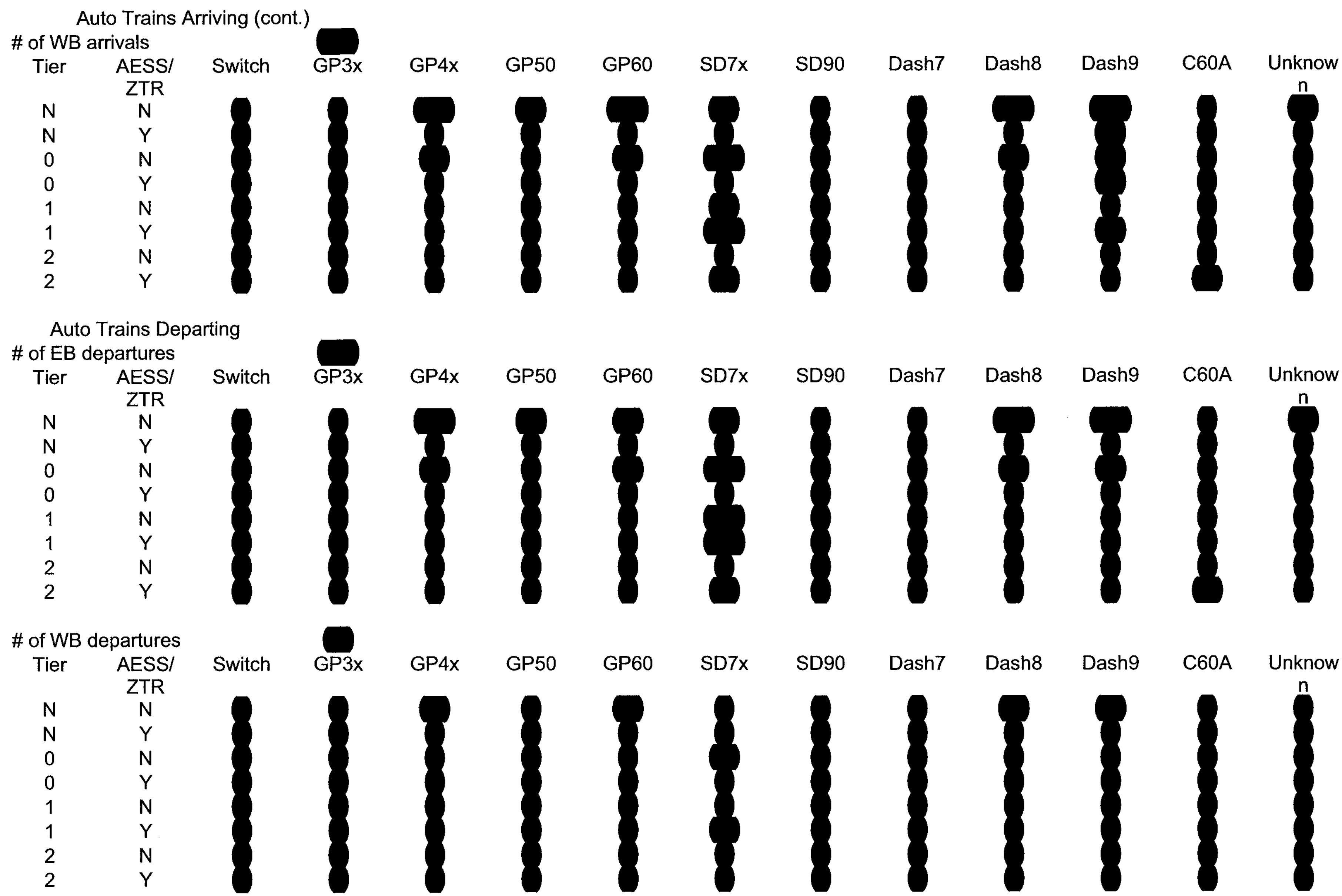
Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Auto Trains Arriving

# of EB arrivals

[redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]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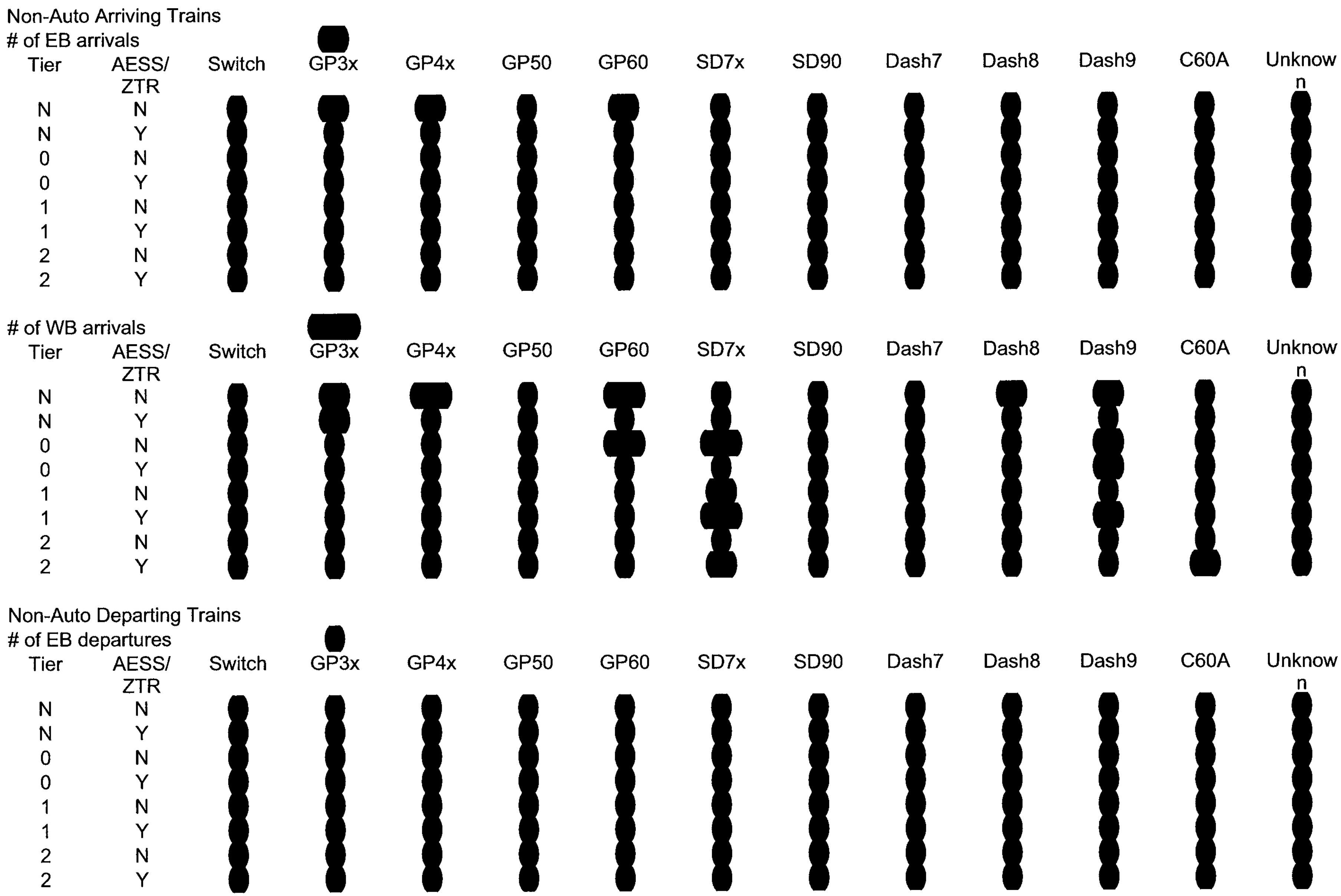
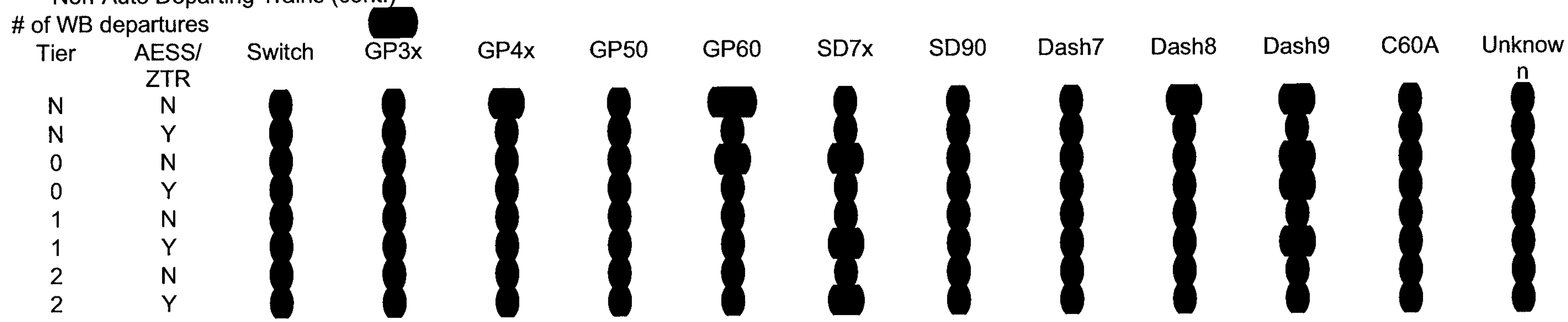
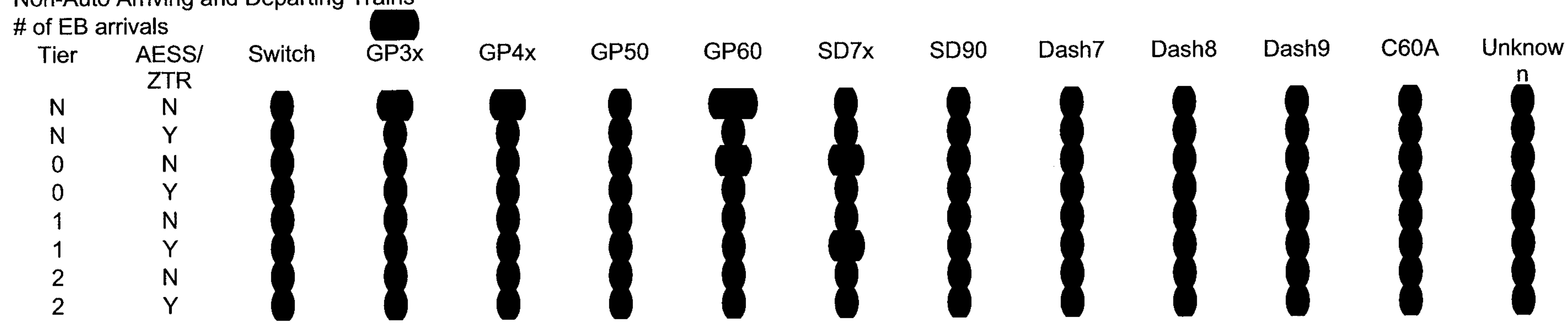
# of WB arrivals
Tier
AESS/ ZTR
Switch
GP3x
GP4x
GP50
GP60
SD7x
SD90
Dash7
Dash8
Dash9
C60A
Unknown
N N
N Y
0 N
0 Y
1 N
1 Y
2 N
2 Y
Auto Trains Departing
# of EB departures
Tier
AESS/ ZTR
Switch
GP3x
GP4x
GP50
GP60
SD7x
SD90
Dash7
Dash8
Dash9
C60A
Unknown
N N
N Y
0 N
0 Y
1 N
1 Y
2 N
2 Y
# of WB departures
Tier
AESS/ ZTR
Switch
GP3x
GP4x
GP50
GP60
SD7x
SD90
Dash7
Dash8
Dash9
C60A
Unknown
N N
N Y
0 N
0 Y
1 N
1 Y
2 N
2 Y

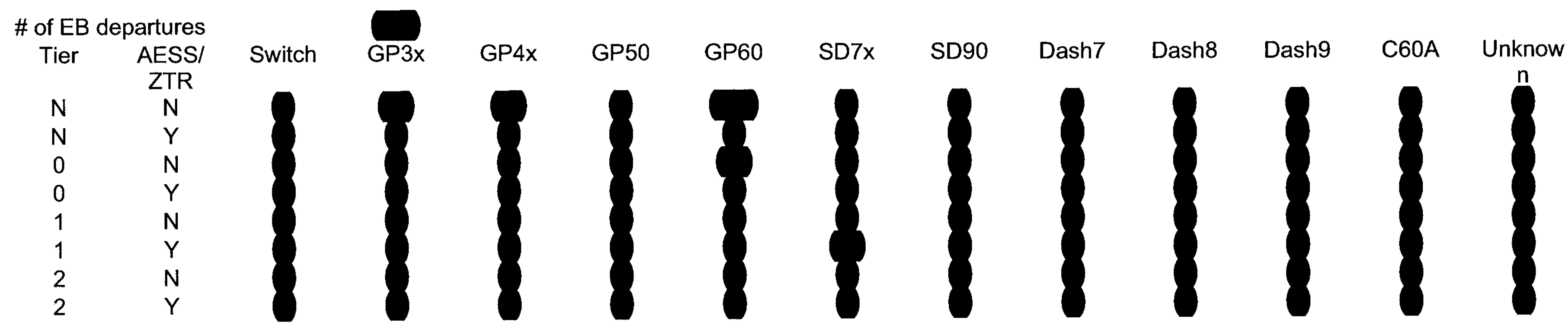

Non-Auto Arriving Trains
# of EB arrivals
Tier
AESS/ZTR
Switch
GP3x
GP4x
GP50
GP60
SD7x
SD90
Dash7
Dash8
Dash9
C60A
Unknown
N N 0 0 1 1 2 2
N Y N Y N Y N Y
# of WB arrivals
Tier
AESS/ZTR
Switch
GP3x
GP4x
GP50
GP60
SD7x
SD90
Dash7
Dash8
Dash9
C60A
Unknown
N N 0 0 1 1 2 2
N Y N Y N Y N Y
Non-Auto Departing Trains
# of EB departures
Tier
AESS/ZTR
Switch
GP3x
GP4x
GP50
GP60
SD7x
SD90
Dash7
Dash8
Dash9
C60A
Unknown
N N 0 0 1 1 2 2
N Y N Y N Y N Y

Non-Auto Departing Trains (cont.)



Non-Auto Arriving and Departing Trains





Non-Auto Arriving and Departing Trains (cont.)

# of WB arrivals

[redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

# of WB departures

[redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Power Moves Through

# of EB arrivals

[redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Power Moves Through (cont.)

[redacted]

# of EB departures

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

# of WB arrivals

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

# of WB departures

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Power Moves Arriving

# of EB arrivals [redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

# of WB arrivals [redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Power Moves Departing

# of EB departures [redacted]

Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Power Moves Departing (cont.) [redacted]

# of WB departures Tier	AESS/ ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
N	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
0	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
2	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

APPENDIX A-2

LOCOMOTIVE MODEL DISTRIBUTION
BY TRAIN TYPE GROUPS

Appendix A2 – Locomotive Model Distribution by Train Type Groups

EB Through Trains

Tier	AESS/ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.013	0.126	0.007	0.391	0.007	0.007	0.007	0.033	0.026	0.000
N	Y	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	N	0.000	0.000	0.000	0.000	0.040	0.093	0.000	0.000	0.013	0.040	0.000
0	Y	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.007	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.086	0.000	0.000	0.000	0.020	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.033	0.000	0.000	0.000	0.000	0.033
Total		0.000	0.013	0.126	0.007	0.430	0.238	0.007	0.007	0.046	0.093	0.033

WB Through Trains

Tier	AESS/ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.002	0.228	0.036	0.079	0.006	0.000	0.004	0.151	0.075	0.000
N	Y	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
0	N	0.000	0.000	0.002	0.000	0.008	0.138	0.000	0.000	0.026	0.025	0.002
0	Y	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.036	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.130	0.000	0.000	0.000	0.009	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.030
Total		0.000	0.002	0.230	0.036	0.089	0.319	0.000	0.004	0.177	0.111	0.032

Auto Trains

Tier	AESS/ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.000	0.111	0.015	0.051	0.010	0.002	0.000	0.102	0.086	0.000
N	Y	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000
0	N	0.000	0.000	0.006	0.001	0.015	0.260	0.001	0.000	0.018	0.033	0.001
0	Y	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.003	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.203	0.000	0.000	0.000	0.008	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.014
Total		0.000	0.001	0.117	0.016	0.067	0.527	0.003	0.000	0.121	0.133	0.015

EB Non-Auto Trains

Tier	AESS/ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.068	0.207	0.000	0.572	0.000	0.000	0.000	0.009	0.005	0.000
N	Y	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
0	N	0.000	0.000	0.001	0.000	0.049	0.018	0.000	0.000	0.002	0.001	0.000
0	Y	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.027	0.000	0.000	0.000	0.013	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.005
Total		0.000	0.077	0.208	0.000	0.622	0.047	0.000	0.000	0.011	0.031	0.005

WB Non-Auto Trains

Tier	AESS/ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.022	0.163	0.005	0.351	0.002	0.001	0.000	0.046	0.031	0.000
N	Y	0.001	0.009	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.000
0	N	0.000	0.000	0.002	0.000	0.087	0.080	0.000	0.000	0.006	0.030	0.000
0	Y	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.015	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.001	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.065	0.000	0.000	0.000	0.044	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.000	0.016
Total		0.001	0.031	0.165	0.005	0.441	0.166	0.001	0.000	0.052	0.123	0.016

Power Moves

Tier	AESS/ZTR	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.001	0.035	0.171	0.007	0.266	0.002	0.002	0.000	0.051	0.040	0.000
N	Y	0.002	0.012	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.004	0.000
0	N	0.000	0.000	0.002	0.001	0.058	0.094	0.001	0.000	0.009	0.035	0.001
0	Y	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.026	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.002	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.062	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000	0.012
Total		0.002	0.047	0.173	0.007	0.325	0.201	0.002	0.000	0.059	0.170	0.012

APPENDIX A-3

SAMPLE CALCULATIONS

Appendix A-3
Sample Calculations

Activity Types	Activity Code	Number of Events/Year	Locomotives per Consist	Emission Factor Group	Locomotives per Consist Working	Fraction of Calif. Fuel
Thru EB Arriving	1	[redacted]	[redacted]	1	[redacted]	0.50
Thru EB Departing	2	[redacted]	[redacted]	1	[redacted]	0.50
Thru WB Arriving	3	[redacted]	[redacted]	2	[redacted]	0.50
Thru WB Departing	4	[redacted]	[redacted]	2	[redacted]	0.50
Auto Trains EB Arrivals	5	[redacted]	[redacted]	3	[redacted]	0.00
Auto Trains WB Arrivals	6	[redacted]	[redacted]	3	[redacted]	0.00
Auto Trains EB Departures	7	[redacted]	[redacted]	3	[redacted]	0.90
Auto Trains WB Departures	8	[redacted]	[redacted]	3	[redacted]	0.90
Other EB Arrivals	9	[redacted]	[redacted]	4	[redacted]	0.00
Other WB Arrivals	10	[redacted]	[redacted]	5	[redacted]	0.00
Other EB Departures	11	[redacted]	[redacted]	4	[redacted]	0.90
Other WB Departures	12	[redacted]	[redacted]	5	[redacted]	0.90
Other EB Arriving and Departing Arrivals	13	[redacted]	[redacted]	4	[redacted]	0.50
Other EB Arriving and Departing Departures	14	[redacted]	[redacted]	4	[redacted]	0.50
Other WB Arriving and Departing Arrivals	15	[redacted]	[redacted]	5	[redacted]	0.50
Other WB Arriving and Departing Departures	16	[redacted]	[redacted]	5	[redacted]	0.50
Power Moves Thru EB Arriving	17	[redacted]	[redacted]	6	[redacted]	0.50
Power Moves Thru EB Departing	18	[redacted]	[redacted]	6	[redacted]	0.50
Power Moves Thru WB Arriving	19	[redacted]	[redacted]	6	[redacted]	0.50
Power Moves Thru WB Departing	20	[redacted]	[redacted]	6	[redacted]	0.50
Power Moves EB Arrivals	21	[redacted]	[redacted]	6	[redacted]	0.00
Power Moves WB Arrivals	22	[redacted]	[redacted]	6	[redacted]	0.00
Power Moves EB Departures	23	[redacted]	[redacted]	4	[redacted]	0.90
Power Moves WB Departures	24	[redacted]	[redacted]	4	[redacted]	0.90
Yard Operations - Two GP-60s	25	[redacted]	[redacted]	7	[redacted]	1.00

Appendix A-3
Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Consist Emission Factor Groups	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel												
Thru Trains EB	1	32.91	38.33	72.82	47.07	114.37	237.15	269.81	345.72	547.14	646.21	778.71
Thru Trains WB	2	29.45	34.27	71.37	50.2	109.61	224.81	266.9	337.06	516.29	595.21	710.83
Auto Trains	3	22.65	29.83	54.55	46.57	93.97	218.1	278.47	357.45	568.6	659.73	759.47
Other Trains EB	4	42.48	44.24	85.26	44.41	124.87	242.19	255.98	320.68	539.62	650.56	814.79
Other Trains WB	5	34.65	38.46	74.5	45.73	116.24	234.11	265.66	342.08	540.81	651.15	795.21
Power Moves	6	32.47	37.51	73.43	45.97	114.88	230.33	264.07	341.94	532.09	627.43	764.66
Yard Operations (GP-60)	7	47.94	47.94	80.04	35.7	134.3	211.93	228.61	289.68	488.55	584.17	749.94
47-State Fuel												
Thru Trains EB	1	32.91	38.33	72.82	47.07	114.37	254.92	300.08	391.1	611.45	714.01	862.33
Thru Trains WB	2	29.45	34.27	71.37	50.2	109.61	244.92	296.5	379.71	578.8	669.85	805.06
Auto Trains	3	22.65	29.83	54.55	46.57	93.97	236.41	309.53	403.5	636.43	735.54	852.12
Other Trains EB	4	42.48	44.24	85.26	44.41	124.87	257.49	284.99	364.64	601.16	707.25	887.42
Other Trains WB	5	34.65	38.46	74.5	45.73	116.24	251.41	295.48	387.15	604.3	718.51	879.84
Power Moves	6	32.47	37.51	73.43	45.97	114.88	248.18	293.61	386.35	595.24	696.4	851.32
Yard Operations (GP-60)	7	47.94	47.94	80.04	35.7	134.3	224.5	254.62	330.01	543.65	631.56	812.06

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Locomotive Model Distributions

Thru Trains EB

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0197	0.1250	0.0066	0.3816	0.0066	0.0066	0.0066	0.0329	0.0263	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0395	0.0921	0.0000	0.0000	0.0132	0.0395	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0066	0.0000	0.0000	0.0000	0.0066	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0132	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0921	0.0000	0.0000	0.0000	0.0197	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0329	0.0000	0.0000	0.0000	0.0329	0.0000

Thru Trains WB

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0019	0.2283	0.0359	0.0793	0.0057	0.0000	0.0038	0.1509	0.0755	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000
Tier 0	No	0.0000	0.0000	0.0019	0.0000	0.0076	0.1377	0.0000	0.0000	0.0264	0.0245	0.0019
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0359	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1302	0.0000	0.0000	0.0000	0.0094	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0094	0.0000	0.0000	0.0000	0.0302	0.0000

Auto Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0002	0.1114	0.0149	0.0510	0.0099	0.0022	0.0000	0.1023	0.0862	0.0000
Pre Tier 0	Yes	0.0000	0.0006	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0038	0.0000
Tier 0	No	0.0000	0.0000	0.0060	0.0006	0.0151	0.2600	0.0010	0.0000	0.0183	0.0326	0.0006
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0004	0.0010	0.0000	0.0000	0.0000	0.0028	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0401	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.2034	0.0000	0.0000	0.0000	0.0081	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0129	0.0000	0.0000	0.0000	0.0143	0.0000

Other Trains EB

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0685	0.2029	0.0000	0.5801	0.0000	0.0000	0.0000	0.0089	0.0045	0.0000
Pre Tier 0	Yes	0.0000	0.0089	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000
Tier 0	No	0.0000	0.0000	0.0009	0.0000	0.0507	0.0169	0.0000	0.0000	0.0018	0.0009	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0080	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0240	0.0000	0.0000	0.0000	0.0125	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000	0.0000	0.0045	0.0000

Other Trains WB

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0002	0.0337	0.1860	0.0043	0.3614	0.0013	0.0009	0.0000	0.0400	0.0270	0.0000
Pre Tier 0	Yes	0.0004	0.0125	0.0004	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000
Tier 0	No	0.0000	0.0000	0.0020	0.0000	0.0867	0.0690	0.0000	0.0000	0.0050	0.0260	0.0002
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0009	0.0009	0.0000	0.0000	0.0000	0.0128	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0102	0.0000	0.0000	0.0000	0.0011	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0562	0.0000	0.0000	0.0000	0.0385	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0061	0.0000	0.0000	0.0000	0.0136	0.0000

Power Moves

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0005	0.0556	0.1662	0.0057	0.3140	0.0015	0.0015	0.0000	0.0432	0.0340	0.0000
Pre Tier 0	Yes	0.0026	0.0154	0.0000	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0036	0.0000
Tier 0	No	0.0000	0.0000	0.0026	0.0005	0.0576	0.0798	0.0005	0.0000	0.0072	0.0299	0.0005
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0005	0.0010	0.0000	0.0000	0.0000	0.0221	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0082	0.0000	0.0000	0.0000	0.0021	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0757	0.0000	0.0000	0.0000	0.0525	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0052	0.0000	0.0000	0.0000	0.0098	0.0000

Yard Operations (GP-60)

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Appendix A-3
Sample Calculations

Track Segment	Segment Number	Length (mi)	
Sidings 101 and 102 West End	1	0.4486	SdngW
Sidings 101 and 102 East End	2	0.6987	SdngE
Sidings E End to Mira Loma Storage Tracks	3	0.3816	Sdng-ML
Main Line W of Etiwanda	4	1.1469	MLW
Main Line E of Etiwanda	5	1.3168	MLE
Storage Tracks on N Side of Yard	6	0.5452	Storage
Pullback Track	7	0.2865	Pullback
Pullback Track to Unloading Track	8	0.2720	PB-Unld

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Moving	Duty Cycle Working	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Working Time (hrs)	Fraction of Segment Moving
Thru EB Arriving	1	4	50	1	--	0	0	0	1
Thru EB Departing	2	5	50	1	--	0	0	0	1
Thru WB Arriving	3	5	50	1	--	0	0	0	1
Thru WB Departing	4	4	50	1	--	0	0	0	1
Auto Trains EB Arrivals	5	1	10	2	3	0	0	0.5	1
"	5	2	10	2	3	0	0	0.5	0.6
"	5	3	10	2	3	0	0	0.5	0
Auto Trains WB Arrivals	6	5	10	2	3	0	0	0	1
"	6	2	10	2	3	0	0	0.5	1
"	6	1	10	2	3	0	0	0.5	0.6
"	6	3	10	2	3	0	0	0.5	0
Auto Trains EB Departures	7	1	10	2	3	0	0	0.7	0
"	7	2	10	2	3	1.5	0.5	0.7	0.4
"	7	3	10	2	3	0	0	0.6	0
"	7	5	10	2	3	0	0	0	1
Auto Trains WB Departures	8	1	10	2	3	1.5	0.5	0.7	0.4
"	8	2	10	2	3	0	0	0.7	0
"	8	3	10	2	3	0	0	0.6	0
Other EB Arrivals	9	1	10	2	3	0	0	0	1
"	9	2	10	2	3	0.5	0.5	0.25	0.6
Other WB Arrivals	10	5	10	2	3	0	0	0	1
"	10	2	10	2	3	0	0	0	1
"	10	1	10	2	3	0.5	0.5	0.25	0.6
Other EB Departures	11	2	10	2	3	1.5	0.5	0.5	0.4
"	11	5	10	2	3	0	0	0	1
Other WB Departures	12	1	10	2	3	1.5	0.5	0.5	0.4
Other EB Arriving and Departing Arrivals	13	1	10	2	3	0	0	0	1
"	13	2	10	2	3	0	0	0.25	0.6
Other EB Arriving and Departing Departures	14	2	10	2	3	0	0	0.5	0.4
"	14	5	10	2	3	0	0	0	1
Other WB Arriving and Departing Arrivals	15	5	10	2	3	0	0	0	1

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Moving	Duty Cycle Working	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Working Time (hrs)	Fraction of Segment Moving
"	15	2	10	2	3	0	0	0	1
"	15	1	10	2	3	0	0	0.25	0.6
Other WB Arriving and Departing Departures	16	1	10	2	3	0	0	0.5	0.4
Power Moves Thru EB Arriving	17	4	50	1	--	0	0	0	1
Power Moves Thru EB Departing	18	5	50	1	--	0	0	0	1
Power Moves Thru WB Arriving	19	5	50	1	--	0	0	0	1
Power Moves Thru WB Departing	20	4	50	1	--	0	0	0	1
Power Moves EB Arrivals	21	1	10	2	3	0	0	0	1
"	21	2	10	2	3	0.5	0.5	0	0.6
Power Moves WB Arrivals	22	5	10	2	3	0	0	0	1
"	22	2	10	2	3	0	0	0	1
"	22	1	10	2	3	0.5	0.5	0	0.6
Power Moves EB Departures	23	2	10	2	3	1.5	0.5	0.5	0.4
"	23	5	10	2	3	0	0	0	1
Power Moves WB Departures	24	1	10	2	3	1.5	0.5	0.5	0.4

Notes
(1) Non-ZTR Idling is the duration of an idle event when units without ZTR continue to idle after ZTR-equipped units have shut down
(2) Idling All is the duration of idling during which all locomotives continue to idle
(3) Working Time is the duration of pushing or pulling of road power in the sidings and the lead from the sidings to the storage tracks
(4) Fraction of Segment Moving is the fraction of the length of the segment over which the movement occurs

Appendix A-3
Sample Calculations

Yard Operations	Activity Code	Segment Number	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Working Time (hrs)
Yard Operations - Storage Track	25	6	4	0	0	4
Yard Operations - Pullback Track	25	7	4	0	0	10
Yard Operations - Pullback to Unloading Track	25	8	4	0	0	7

Duty Cycles (Percent of Time by Notch)	Duty Cycle Number	Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8
Thru Trains and Power Moves	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%
Arriving and Departing Trains	2	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Road Power Working	3	50.0%	0.0%	0.0%	20.0%	20.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Yard Operations	4	50.0%	0.0%	0.0%	0.0%	20.0%	20.0%	10.0%	0.0%	0.0%	0.0%

Appendix A-3
Sample Calculations

Example 1 -- WB Arriving Auto Train

Parameter	Value
Activity Code	6
Number of Events	[redacted]
Locomotives per Consist on Train	2.635
Emission Factor Group	3
California Fuel Fraction	0.00

Segment	Segment Number	Length (miles)	Speed (mph)	Power Move	Non-ZTR Idle (hrs)	ZTR Idle (hrs)	Working Time (hrs)	Locomotive Hours Moving	Locomotive Hours Working	Locomotive Hours NonZTR Idle	Locomotive Hours ZTR Idle
Main Line E of Etiwanda	5	1.317	10	N	0	0	0	338.65	0.00	0.00	0.00
Sidings E End	2	0.699	10	N	0	0	0.5	179.69	1285.88	0.00	0.00
Sidings W End	1	0.449	10	N	0	0	0.5	115.37	1285.88	0.00	0.00
Sidings to Storage Track	3	0.382	10	N	0	0	0.5	98.14	1285.88	0.00	0.00
Total								*731.85*	*3857.64*	*0.00*	*0.00*

Emission Factors - Auto Trains	Consist/Duty Cycle ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel	3	22.65	29.83	54.55	46.57	93.97	218.10	278.47	357.45	568.60	659.73	759.47
47-State Fuel	3	22.65	29.83	54.55	46.57	93.97	236.41	309.53	403.50	636.43	735.54	852.12
Fuel Fraction Adjusted Rates		*22.65*	*29.83*	*54.55*	*46.57*	*93.97*	*236.41*	*309.53*	*403.50*	*636.43*	*735.54*	*852.12*
Duty Cycle Moving	2	0%	0%	0%	50%	50%	0%	0%	0%	0%	0%	0%
Duty Cycle Working	3	0%	50%	0%	0%	20%	20%	10%	0%	0%	0%	0%
Weighted g/hr emissions - Moving		0.00	0.00	0.00	23.29	46.99	0.00	0.00	0.00	0.00	0.00	0.00
Weighted g/hr emissions - Working		0.00	14.92	0.00	0.00	18.79	47.28	30.95	0.00	0.00	0.00	0.00

	Moving	Working	Idle-NonZTR	Idle-All
Emission Rate (g/hr)	70.27	111.94	22.65	29.83
Locomotive Hours	731.85	3857.64	0.00	0.00
Emissions (g/yr)	**51427**	**431840**	**0**	**0**

Total Emissions (g/yr) **483266**

APPENDIX A-4

METHODOLOGY FOR ESTIMATING LOCOMOTIVE EMISSIONS AND GENERATING AERMOD EMISSION INPUTS

Appendix A-4

Methodology for Estimating Locomotive Emissions and Generating AERMOD Emission Inputs

Overview

This appendix describes the general procedures followed for developing locomotive emission inventories for the Union Pacific Railroad (UPRR) rail yards under the Memorandum of Understanding with the California Air Resources Board. It also describes the procedure by which the emission inputs for both locomotive and non-locomotive sources used in AERMOD dispersion modeling.

EMISSION CALCULATIONS

This section describes the details of the development of activity inputs, emission factors, and emission estimates for locomotive operations. Separate procedures are followed for estimating activity associated with locomotives on trains, locomotive consist movements within a yard, service and shop activity (if occurring at a specific yard), and yard switching operations within a yard. Emission factors are developed for each of the types of locomotive activity based on the model and technology distribution of locomotives involved in each activity. Emission estimates are then developed for the activities and specific areas of a yard in which each activity occurs. The data used to calculate these emissions are included in the Appendix A-3 Excel workbook, which includes a "Sample Calculations" worksheet showing the linkages between the various activities, emission factors, and operating characteristics data.

Train Activity

Train activity data for emissions calculations includes a number of separate components:

- The number of trains arriving, departing, or passing through a yard, broken down by type of train
- The average composition of working locomotives in each consist[1], including the fraction of locomotives of different models, emissions technology tier, and automatic idling control equipment[2]
- The identification of routes followed for different types of train activities

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[1] The term "consist" refers to the group of locomotives (typically between one and four) that provide power for a specific train.

[2] Two types of automatic idling control equipment are in use, known as ZTR SmartStart (typically retrofit equipment on low horsepower units) and AESS (typically factory installed on newer high horsepower units). Both are programmed to automatically shut of the engines of parked idling locomotives after a specified period of time, and to restart the unit if any of a number of operating parameters (battery state, air pressure, coolant temperature, etc.) reach specified thresholds.

- Identification of the speeds and throttle settings for different types of train activities in different locations.

The primary source of information for estimating train activity is a database identifying the arrival and departure of locomotives at a specific yard. This database identifies locomotives by their ID numbers and models, the status on the train (working or not working), and the specific train to which they are connected. From these data, the total numbers of trains of different types are identified based on train symbols, train dates, train origination and termination indicators, and dates and times of arrival and departure. For each type of train and activity, the average number of locomotives per consist is calculated along with the distribution of locomotive models, emission technology tiers, and automatic idling control equipment. A separate database of UPRR locomotives is consulted based on locomotive ID to determine the tier and date of any retrofits of automatic idling controls to complete the development of these model distributions. The activity data so derived are shown on the "Activities" worksheet in the Appendix A-3 Excel workbook, and the model and technology distributions are shown on the "Consist Emissions" worksheet.

The types of trains to be identified can vary from yard to yard. For all yards, through trains (which bypass the yard itself on mainline tracks adjacent to the yard) are identified. Depending on the yard, trains entering or departing from the yard can be of several types, including:

- Intermodal trains
- Automobile trains
- "Manifest" or freight trains
- Local trains
- Power moves

Power moves are trains consisting only of locomotives which are either arriving at the yard to be serviced or used for departing trains, or departing from the yard to be serviced at another location or used for trains departing from another location. The routes followed by each type of train on arrival and departure are identified in consultation with UPRR yard personnel, along with estimates of average speeds and duty cycles (fraction of time spent at different throttle settings) for different areas.

Specific track subsections are identified by UTM coordinates digitized from georeferenced aerial photographs. The segments identified and their lengths are shown on the "Track Segments" worksheet of Appendix A-3. For each train type, direction, and route, a listing of track segments, segment lengths, and duty cycles is developed. Duty cycles are shown on the "Consist Emissions" worksheet of Appendix A-3, and the segment speeds, duty cycles, idling durations are shown on the "Movements and Yard Operations" worksheet. This listing, along with the number of locomotives per consist and number of trains of each type, allows calculation of the number of locomotive hours in each duty cycle to be calculated for each section of track. For arriving and departing trains, estimates of the duration of idling were developed in consultation with UPRR personnel. These idling periods were divided into two parts – the assumed amount of time that all locomotives in a consist would idle on arrival or departure, and the amount of time that only locomotives not equipped with automatic idle controls would idle. Idling periods were assigned to a segment of the arrival or departure track one fifth of the length of the track at the appropriate end.

Service and Shop Activity

If there is a service track and/or shop at a yard, locomotives (including both road power from trains as well as yard switchers) undergo a variety of activities at these locations. If present at a yard, details of the service and shop activity, model distributions, and emission factors are shown on the "Service and Shop" worksheet of Appendix A-3. Specific locomotive activities involve idling while awaiting or undergoing routine service (cleaning, refueling, oiling, sanding, and other minor maintenance), movement and idling between service and maintenance areas, and stationary load testing associated with specific types of maintenance events. A database of service events at individual yards identifies the number of service events during the year, the locomotive ID and model, and the nature of servicing performed. Routine servicing involves periods of idling prior to and during service, and additional idling prior to movement of consists to departing trains in the yard. Estimates of the duration of idling associated with servicing are developed in consultation with UPRR personnel. As was done for trains, these idling periods were separated into two parts, the average total duration of idling by all locomotives, and the average duration of additional idling by locomotives not equipped with automatic idling controls.

The database also specifically identifies load test events and the type of maintenance with which the load testing is associated. These types include planned maintenance at different intervals (e.g., quarterly, semiannual) as well as unscheduled maintenance which may involve both diagnostic load testing prior to maintenance and post-maintenance load testing. The duration of load test events in each throttle setting depend on the equipment available and types of maintenance performed at the yard. Estimates of these durations, as well as the identification of load testing activity by type of load test and the time and duration of any additional idling and movements are developed in consultation with UPRR personnel.

A total number of events (servicing and load testing by location and type) are developed from these data, as are locomotive model and technology distributions for all locomotives serviced and for those specific locomotives undergoing load testing (if applicable). From these event counts and durations, the total number of hours of locomotive idling and higher throttle setting operation in different portions of the service areas are calculated for each of the two model distributions.

Yard Switcher Activity

In each yard, there are routine jobs assigned to individual switchers or sets of switchers. These activities are generally not tracked from hour to hour, but they occur routinely within yard boundaries during specified work shifts. Similarly, the specific yard switcher locomotive IDs assigned to these jobs are not routinely tracked, but these yard jobs are generally assigned to a specific model of low horsepower locomotive. From the assigned yard switcher jobs and shifts, and in consultation with UPRR personnel, an estimate of the hours per day of switcher operation in a yard are developed, along with the specific times of day when these activities occur (time of day assignments were made only if operation was less than 24 hour per day). Duty cycles for switching operation are also developed in consultation with local UPRR personnel. Depending on the type of activity and type of trains being handled in a yard, duty cycle estimates may vary. In the absence of more detailed information, the USEPA switcher duty cycle is assumed to be representative of each switcher's operation[3]. The total number of locomotive hours of operation for each model are calculated and assigned to the areas in which the units work. In some cases, yard jobs are assigned to specific areas within the yard and specific models of locomotives. In these cases, the switcher activities are assigned specifically to these areas of the yard.

Emission Factor Development

The locomotive model and technology group distributions derived in the development of activity data are grouped by type or types of activity with consideration for the level and nature of the activity. For example, a single distribution is used for through trains of all types, including power moves, while consist model distributions for different types of trains within a yard may be treated as separate distributions if they are handled in different areas of a yard. As shown in Part VII of this report model-group-specific emission factors by throttle setting were developed based on emission test data and sulfur content adjustment factors. From these emission factors and the locomotive model and technology distributions for different types of trains and activities, weighted average emission factors are calculated for the "average" locomotive for that train type or activity on a gram per hour basis. For each train type or activity, two separate idle emission rates are calculated. The first is the straight weighted average emission rate for all locomotives, while the second is the weighted average only for the fraction of locomotives without automatic idle controls. Mathematically,

$$\overline{Q}(l) = \sum_{i=1}^{11} \sum_{j=1}^{4} \sum_{k=1}^{2} F(i,j,k) \cdot Q(i,j,l)$$

for l corresponding to idle through N8, and

$$\overline{Q}(l^*) = \sum_{i=1}^{11} \sum_{j=1}^{4} F(i,j,1) \cdot Q(i,j,l^*)$$

for idling emission rate during periods when only locomotives without automatic idle controls are idling

where

[3] USEPA (1998). Locomotive Emission Standards -- Regulatory Support Document. (Available at *www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

$\overline{\overline{Q}}(l)$ = weighted average emission factor for throttle setting l

$Q(i,j,l)$ = the base g/hr emission factor of a particular model group/technology class and throttle setting

$F(i,j,k)$ = the fraction of locomotives of a particular model group/technology class

i = model group index (Switcher, GP-3x, etc.)

j = technology tier index (pre-Tier 0, Tier 0, Tier 1, Tier 2)

k = automatic idle control status index (with or without)

l = throttle setting (idle, N1, . . ., N8)

l^* = index for idle throttle of locomotives without automatic idle controls.

Thus, for each defined locomotive model distribution, gram per hour emission factors are generated for each throttle setting.

Emission Calculations – Locomotive Movements

From the train activity analysis, the following data are available for each segment of track: track length of segment $L(i)$; speed $V(i)$; movement duty cycle $\boldsymbol{D}(i)$ (a vector of fractions of time spent in each throttle setting); number of trains of each type $N(j)$; and number of working locomotives per consist for each train type $C(j)$. For each type of train j, there is a set of throttle-specific emission factors $Q_j(l)$ for the "average" locomotive used on that train type. If a particular type of train or consist movement can follow multiple paths within the yard, the activity is allocated to sequences of track segments representing each such path. Total annual emissions $q_{tot}(i)$ for each segment are then calculated as

$$q_{tot}(i) = \frac{L(i)}{V(i)} \cdot \sum_j N(j) \cdot C(j) \sum_l D(i,l) \cdot Q_j(l) .$$

Emission Calculations – Locomotive Idling

Locomotive idling is calculated in a similar manner for road power and locomotives in service. For each train type and for service events, activity data provide a number of annual events $N(i)$, duration of idling by locomotives with ($T_{all}(i)$) and without ($T_{nZTR}(i)$)automatic idle control, and gram per hour emission rates for the "average" locomotive $Q_{all}(i)$, and the "average" locomotive excluding those with automatic idle controls $Q_{nZTR}(i)$. Total annual emissions are calculated as

$$q_{idle} = \sum_i N(i) \cdot C(i) \cdot (T_{all}(i) \cdot Q_{all}(i) + T_{nZTR}(i) \cdot Q_{nZTR}(i)) .$$

If a particular type of activity occurs at multiple locations within the yard (e.g., on multiple arrival or departure tracks), then the idling time is allocated to different segments of track as appropriate so that segment-specific emissions are obtained.

Emission Calculations – Load Testing

Load testing emissions are calculated separately for each throttle setting (idle, N1 and N8) using the weighted average emission factors for the load-tested units, the number of load tests of different types, and the duration of testing in each throttle setting for each type of test.

Emission Calculations – Yard Switcher Operations

Activity data provide the number and model group information for yard switchers, and the number of operating hours per day. Model-group specific emission factors are multiplied by the duty cycle to generate weighted average gram per hour emissions for idling and for combined emissions from operation in notch 1 through notch 8. Emissions are calculated directly from the number of units, hours per day working, and duty cycle weighted emission factors for both idle and non-idle throttle settings during work shifts.

AERMOD EMISSION INPUT PREPARATION

Emissions from both locomotives and from other emission sources in a yard are allocated to multiple individual point or volume sources in AERMOD inputs. In addition to each type of activity's emission rates, the locations of emissions, the release parameters, and other inputs (e.g., building downwash parameters, temporal variation in emissions, etc.) are required by AERMOD. Emission inputs are prepared sequentially for different types of activities and the areas within which they occur. The source elevation for each point or volume source is interpolated from a high resolution terrain file.

Locomotive Movements

For each type of locomotive movement, emissions calculated for each track segment are uniformly allocated to a series of evenly spaced volume sources along that track segment. The maximum spacing between sources is specified and the number of sources to be used for each segment is calculated from the segment length. The raw emission rate value in the AERMOD inputs (g/sec) is based directly on the annual emission total for the segment divided by the number of sources on that segment. For locomotive movements, separate day and night release parameters are needed. Therefore, each source is duplicated (but with a different source ID and parameters) in the AERMOD inputs, with temporal profile inputs (EMISFACT HROFDY) that use day time parameters from 0600-1800 and night time parameters for 1800-0600.

Locomotive Idling and Load Testing

Locomotive idling and load testing emissions are allocated to track segments in the same manner as locomotive movements, but as point, rather than volume sources. Each source location may have up to three separate sources identified, with different stack parameters used for idle, notch 1 and notch 8. Building downwash inputs are assigned from a pre-

prepared set of records for a typical locomotives dimensions and the orientation of the track segment on which the emissions occur.

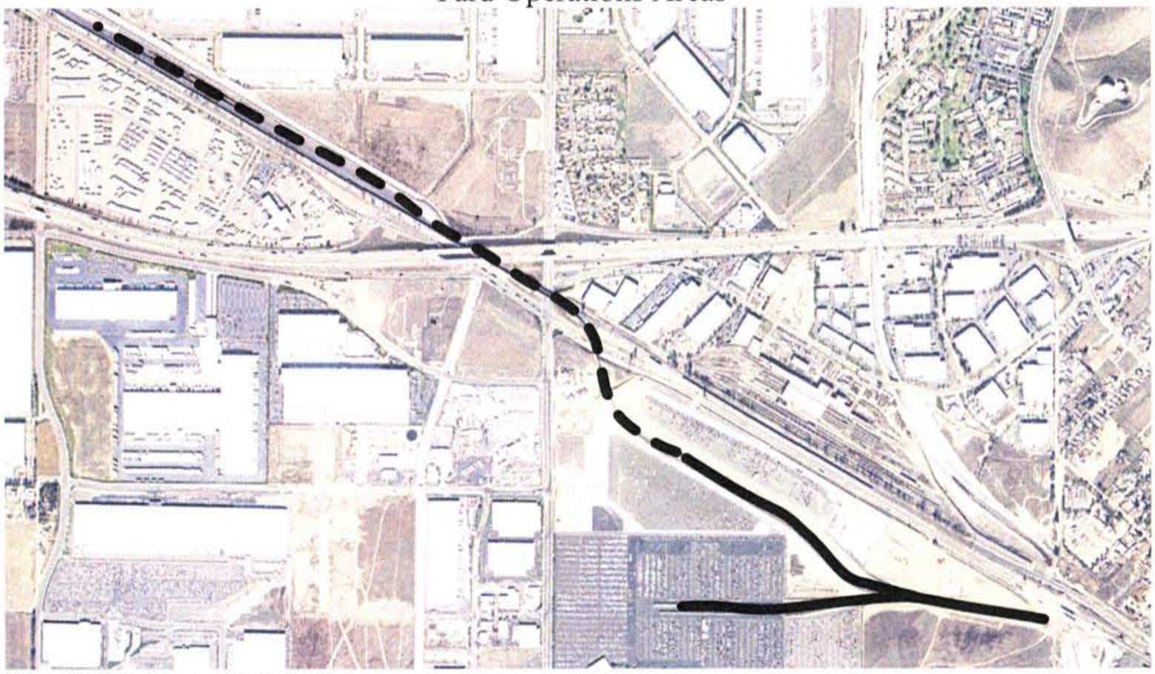
Yard Switcher Operations

Yard switcher operations are allocated to areas within the yard based on the estimated time spent working in each area. As for locomotive movements, yard switcher emissions for a specific area are allocated uniformly to a number of volume sources on defined segments. Day and night operations are handled similarly to train and consist movements, with EMISFACT HROFDY records used to switch day and night volume source release parameters. Depending on their magnitude and distance from yard boundaries, the "working idling" emissions for yard switching may be added to the non-idle emissions from volume sources, or treated as a series of point sources, using stack parameters for the specific model group being used. If treated as point sources, building downwash inputs are prepared as for other locomotive idling and load testing.

APPENDIX A-5

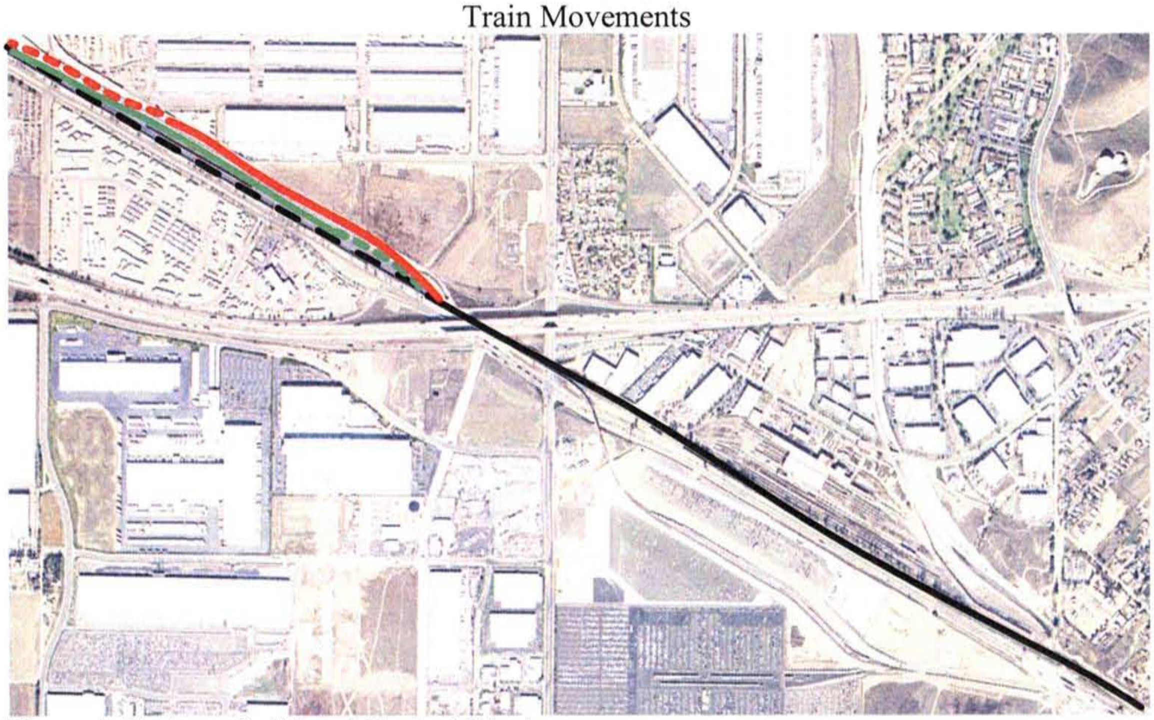
PRINCIPLE LOCOMOTIVE ROUTES

Yard Operations Areas



Yard Switcher – Solid
Road Power – Dashed

Train Movements



Through Trains – Solid and Dashed Black
WB Arrivals – Solid Black and Solid Red
EB Arrivals – Solid Green
WB Departures – Dashed Red
EB Departures – Dashed Green and Solid Black

APPENDIX A-6

IRESON ET AL

Development of Detailed Railyard Emissions to Capture Activity, Technology and Operational Changes

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ABSTRACT

Railyard operations involve a variety of complex activities, including inbound and outbound train movements, classification (i.e., separating cars from inbound trains for redirection to multiple destinations, and building new trains), and servicing locomotives. Standard locomotive duty cycles provide long-term average activity patterns for locomotive operations, but they are not appropriate for the specialized activities that occur within railyards or at locations such as ports, and emission densities in such areas can be high relative to those of line haul activities. There are significant emission rate differences between locomotive models, and differences in the types of service for which specific models are used. Data for throttle-specific emissions, activity levels, and locomotive models and operating practices can be used to provide more accurate emissions estimates for such operations. Such data are needed to quantify actual emissions changes in these high activity areas. A calculation scheme has been developed to generate detailed emission inventories based on the types of data that are collected for managing rail operations. This scheme allows improved accuracy in emissions estimation, and also provides a more reliable basis for bottom-up tracking of emissions changes over time. Factors that can be addressed include: changes in the distribution of locomotive models and control technology levels (e.g., increasing fractions of Tier 0, 1, and 2 locomotives) for both line haul and local operations; actual in-yard idling duration and reductions associated with auto-start-stop technologies; fuel quality effects; and detailed operating practices for switching and train-building operations. By providing detailed disaggregation of activity and emissions data, the method also makes it possible to quantify and evaluate the effects of specific emission reduction alternatives.

INTRODUCTION

Freight movement by rail is a key component of the U.S. transportation infrastructure. The combination of rail's low rolling resistance and the fuel-efficient turbocharged diesel engines used in modern locomotives make rail the most efficient mode of transport from both an emissions and economic perspective. Railyards located strategically through the nation's rail network are used to assemble and direct goods movement to their destinations. Railyards may handle dozens of trains per day, each powered by a "consist" of several locomotives. While in railyards, these locomotives are serviced and regrouped into new consists as needed for specific departing trains. In addition to train arrivals and departures and locomotive servicing, so-called "classification" yards separate rail cars in inbound trains into segments with different destinations, and build new trains with a common destination. This work is accomplished by switcher locomotives (typically of lower horsepower than the locomotives used for "line-haul" operations). Some railyards also have major locomotive repair facilities whose activities include load testing of locomotives prior to or after maintenance. Collectively, the locomotive operations associated with these activities can result in relatively high localized emission densities.

The Union Pacific Railroad (UPRR) is the largest railroad in North America, operating throughout the western two-thirds of the United States. It operates a number of railyards throughout its system, including the J. R. Davis Yard in Roseville, California. The Davis Yard is UPRR's largest classification yard in the western U.S. It is approximately one-quarter mile wide and four miles long, and is visited by over 40,000 locomotives per year. The California Air Resources Board (CARB) recently completed a detailed dispersion modeling study to estimate concentrations of diesel particulate matter in the vicinity of the railyard.[1] UPRR cooperated closely with CARB in this study, including the identification, retrieval and analysis of data needed to assemble a detailed emission inventory for railyard operations. This effort produced the most detailed emission inventory for railyard operations to-date, including empirically developed train counts, locomotive model distributions, locomotive service and maintenance activities, and dedicated on-site switching operations. The results of this effort have been further adapted to allow UPRR to track the effect of locomotive fleet modernization, freight volume, and operational changes on emissions, and to identify opportunities for further emission reductions at the Davis Yard.

RAILYARD ACTIVITY ESTIMATION

At state and national levels, locomotive emissions have been estimated using locomotive fleet population data and average locomotive emission factors, expressed in g/bhp-hr, in conjunction with fuel efficiency estimates and fuel consumption. For freight locomotives, the emission factors are typically derived using both a switching duty cycle and a line haul duty cycle, each of which gives the fraction of operating time locomotives spend at different throttle settings, referred to as notch positions.[2] These throttle settings (see Table 1) include idle, notches 1 through 8, and dynamic braking (in which the locomotive traction motors are used to generate power which is dissipated through resistor grids). While this approach can provide reasonable estimates for larger regions, neither the overall locomotive fleet composition nor the standard duty cycles accurately reflect the specific activities that occur within an individual railyard. The g/bhp-hr emission factors vary substantially between throttle settings and between locomotive models. Other confounding factors include: speed limits within yards (which preclude the high throttle settings used for line-haul activity outside of yards); locomotive load (consists commonly move within yards with only one locomotive pulling and no trailing cars); and time spent either shut down or idling. Classification activities are carried out with duty cycles that are unique to yard operations and may vary from yard to yard. To develop more accurate emissions estimates, it is necessary to explicitly identify railyard activities at the level of individual locomotives.

Table 1. Locomotive Duty Cycles.

	Throttle Position (Percent Time in Notch)									
Duty Cycle	**D.B.**	**Idle**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
EPA Line-Haul	12.5	38.0	6.5	6.5	5.2	4.4	3.8	3.9	3.0	16.2
EPA Switch	0.0	59.8	12.4	12.3	5.8	3.6	3.6	1.5	0.2	0.8
Trim Operations	0.0	44.2	5.0	25.0	2.3	21.5	1.5	0.6	0.0	0.0
Hump Pull-Back	0.0	60.4	12.5	12.4	5.9	3.6	3.6	1.5	0.0	0.0
Hump Push	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0
Consist Movement	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
Load Tests:										
10-Minute	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0
15-Minute	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7
30-Minute	0.0	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	33.3

To accomplish this, UPRR reviewed the types of databases available for its operations to identify where explicit emission-related activity information could be generated for the Davis Yard. UPRR operates approximately 7000 locomotives over a network spanning 23 states. Large amounts of data are generated and retained by UPRR for management purposes. These include tracking the location and status of capital assets (e.g., locomotives and rail cars), tracking performance of specific activities, and managing operations. These databases can be queried for data records specific to the Davis Yard, but their content does not directly relate to emissions. Where possible, data providing a complete record of emissions-related events (e.g., locomotive arrivals and departures) were identified and retrieved. Where 100 percent data for an activity could not be obtained (e.g., locomotive model number for each arriving locomotive), distributions were developed based on available data. In some cases, data are not available for specific types of emission events (e.g., the duration of idling for individual trains prior to departure). In these cases, UPRR yard personnel were consulted to derive estimates of averages or typical operating practices.

Railyard Operations – Inbound and Outbound Trains

The majority of locomotive activity in a railyard arises from inbound and outbound freight traffic. Following arrival, consists are decoupled from their trains in receiving areas and are either taken directly to outbound trains, or more commonly, are sent through servicing which can include washing, sanding, oiling, and minor maintenance prior to connecting to outbound trains. Some fraction of trains arriving at a yard simply pass through, possibly stopping briefly for a crew change. UPRR maintains a database that, when properly queried, can produce detailed information regarding both arriving and departing trains. Table 2 lists some of the key parameters that are available in this database. In this study, 12 months of data were obtained for all trains passing through the Davis Yard. The extracted data (over 60,000 records) included at least one record for every arriving and departing train, and each record contained specific information about a single locomotive, as well as other data for the train as a whole. The data were processed using a commercial relational database program and special purpose FORTRAN code to identify individual train arrivals and departures and train and consist characteristics.

Table 2. Selected Train Database Parameters.

	Used to Identify				
Parameter	Identification of Train Events	Location in Railyard	Consist Composition	Temporal Profile	Train Characteristics
Train Symbol	X	X			
Train Section	X				
Train Date	X				
Arrival or Departure	X	X			
Originating or Terminating	X	X			
Direction		X			
Crew Change?		X			
Arrival & Departure Times				X	
# of Locomotives			X		
# of Working Locomotives			X		
Trailing Tons					X
Locomotive ID #			X		
Locomotive Model			X		

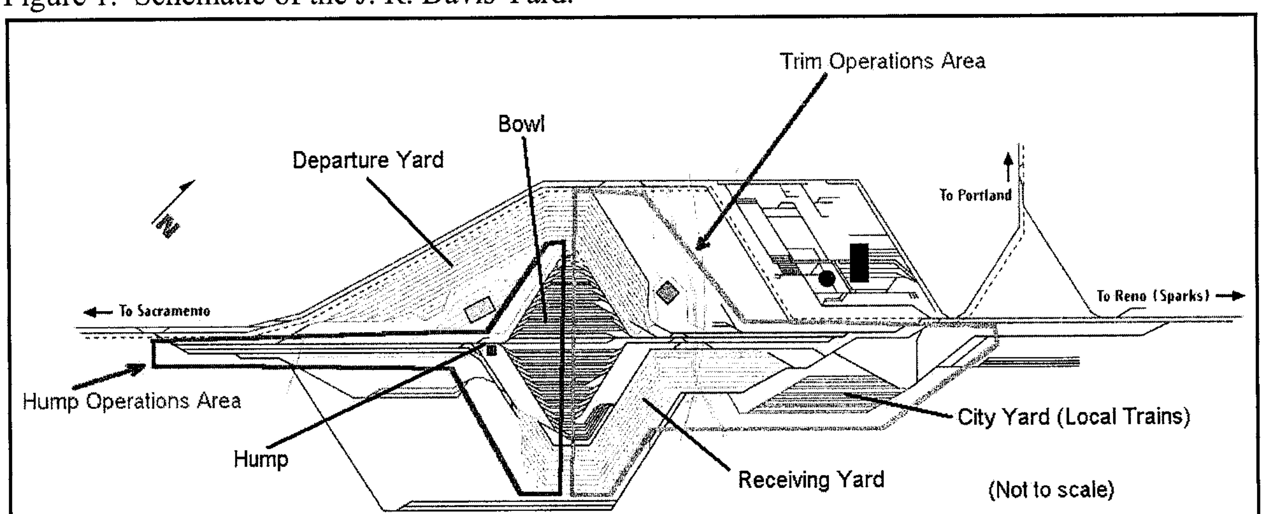
The parameters listed in Table 2 were used to calculate the number of trains by time of day arriving or departing from each area of the yard, as well as average composition of their consists (number of locomotives and distribution of locomotive models). The combination of train symbol, train segment, and train date provided a unique identifier for a single arrival or departure, and the individual locomotive models were tabulated to generate model distributions. Where necessary, working horsepower and total horsepower were used to estimate the number of working locomotives in the consist.

Emission calculations associated with inbound and outbound trains included both periods of movement within the yard boundaries and locomotive idling while consists we connected to their trains. Based on train direction and the location of its arrival or departure, moving emissions were based on calculations of time at different throttle settings based on distance traveled and estimated speed profiles, considering speed limits on different tracks. Yard operators provided estimates for the average duration of such idling for both inbound and outbound trains.

Railyard Operations – Classification

On arrival, inbound trains are "broken" into sections of rail cars destined for different outgoing trains. Figure 1 shows a schematic diagram of the Davis Yard including a large central "bowl" consisting of a large number of parallel tracks connected by automated switching controls to a single track to the west. Trains are pulled back to the west and then pushed to the "hump," a slightly elevated portion of track just west of the bowl. As cars pass over the hump, they are disconnected and roll by gravity into the appropriate track in the bowl. Dedicated special purpose locomotives, known as "hump sets," are used in this operation. Unlike most locomotives, these units have continuously variable throttles, rather than discrete throttle notch settings, to allow precise control of speed approaching the hump. Switching locomotives, known as "trim sets" are responsible for retrieving the train segments or trains being "built" in the bowl and moving them to the appropriate outbound track. The Davis Yard operates a fixed number of hump sets and trim sets at any given time, with backup sets standing by for shift changes and possible breakdowns.

Figure 1. Schematic of the J. R. Davis Yard.



Emission calculations for hump and trim operations were based on the number of working hump and trim sets at any given time, plus assumed idling times of standby units. For the hump sets, yard operators provided estimates of average pull-back and pushing times, and the duty cycles associated with these operations. For pull-back, based on distance and speed limits, the EPA switcher duty cycle, excluding notch 7 and 8 was used. Pushing is conducted at the equivalent of notch 2. For the trim sets, speed limits within the Yard preclude any high throttle setting operation, but there is a greater time spent in mid-throttle settings than reflected in the EPA switcher cycle. A revised duty cycle was developed for these units based on the EPA switcher duty cycle, with high throttle fractions (notches 7 and 8) excluded, but with increased notch 1 and notch 4 operating time. These duty cycles are also shown in Table 1.

Railyard Operations – Consist Movement, Service, Repair and Testing

After disconnecting from inbound trains, consists move to one of several servicing locations for refueling and other maintenance, following designated routes in the yard. Typically, one locomotive in each consist will pull the others, with throttle settings at notch 1 or 2. Based on distance and speed limits, movement times were estimated for each route, and emissions calculated using the number of locomotives following each route.

While being serviced, locomotives may be either idling or shut down. Locomotives must be idling while oil and other routine checks are performed. In addition, since locomotive engines are water-cooled and do not use antifreeze, they are commonly left idling during cold weather conditions. New idling reduction technologies known as SmartStart and AESS provide computer-controlled engine shut down and restart as necessary, considering temperature, air pressure, battery charge, and other parameters. Yard personnel provided estimates of the average potential duration of idling associated with different servicing events. Databases for service and maintenance activities maintained by UPRR provide details on the number and types of service events at different locations in the yard. As for train activity, these data were processed with a commercial relational database program and special purpose FORTRAN code to characterize and tabulate service events. These results were used in conjunction with data for the number of inbound and outbound consists to estimate total idling emissions for different service event types and locations. Following service, consists are dispatched to outbound trains. The same procedures were followed for estimating idle time, number of locomotives moving to each outbound area of the yard, and the duration of each movement for emission calculations.

In addition to routine service, the databases include service codes indicating periodic inspections of various types, as well as major maintenance activities requiring load testing of stationary locomotives. Several types of load tests are conducted, including planned maintenance pre- and post-tests, quarterly maintenance tests, and unscheduled maintenance diagnostic and post-repair tests. Depending on the test type and locomotive model, these tests include some period of idling, notch 1 operation, and notch 8 operation. Data are not collected on the exact duration of individual tests, so estimates of average duration for each throttle setting were provided by shop personnel, as shown in Table 1. The number of tests of each type for each locomotive model group were tabulated based on the service codes in the database for each service event.

Trends in Activity and Technology

The initial study was based on data from December 1999 through November 2000. Since that time, UPRR's locomotive fleet modernization program as well as changes in freight volumes have occurred. A subsequent data retrieval for the period from May 2003 through April 2004 was made, and emission calculations updated. A number of significant changes occurred over this 40-month period. The distribution of locomotive models in line-haul operation showed a substantial shift from older, lower horsepower units to new high horsepower units. The average number of locomotives per consist remained the same at about 3, but the higher horsepower allowed an increase in train capacity (trailing tons per train). The decrease in older units also resulted in a decrease in the frequency of major maintenance load testing. In addition to updating activity inputs (number of locomotives by model) for emission calculations, calculations were modified to reflect the penetration of new and retrofit technologies in the locomotive fleet, including SmartStart and AESS idling controls and Tier 0 and Tier 1 locomotives. UPRR data identifying the specific technologies installed on individual locomotives were matched with locomotive ID numbers in the train and servicing data retrievals to obtain a specific count of the number of locomotives of each model for which emissions reductions were achieved by these technologies. Historical temperature data for the Roseville area were used to estimate the fraction of time computer controls would require idling when the locomotive would otherwise be shut down.

EMISSION FACTORS

Data Sources

The study of the J. R. Davis Yard focused on diesel exhaust particulate matter emissions. At present, there is no unified database of emission test results for in-use locomotives. Appendix B of the USEPA's Regulatory Support Document for setting new emission standards for locomotives[2] contains a compilation of notch-specific emission factors. These data were supplemented by test data reported by Southwest Research Institute[3,4], as well as test data provided by locomotive manufacturers to assemble emission factors for each of 11 locomotive model groups.

There are dozens of specific locomotive model designations, and emissions tests are not available for all of them. However many models are expected to have nearly identical emission characteristics. Depending on their intended use, locomotives of different models may have different configurations (e.g., number of axles), but share a common diesel engine. For this project, 11 locomotive model groups were defined based on their engine models (manufacturer, horsepower, number of cylinders, and turbo- or super-charging of intake air). Table 3 lists these model groups and some of the typical locomotive models assigned to each group.

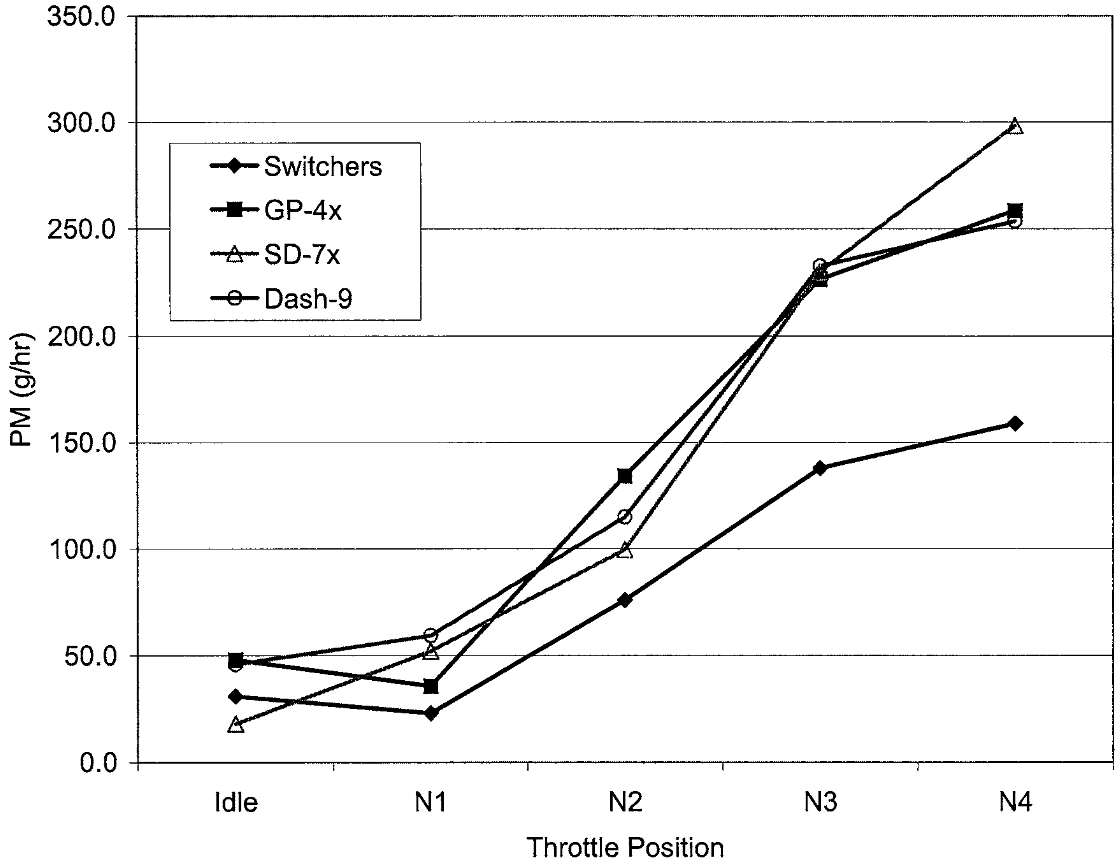
Table 3. Locomotive Model Groups

Model Group	Engine Family	Representative Models
Switchers	EMD 12-645E	GP-15, SW1500
GP-3x	EMD 16-645E	GP-30, GP-38
GP-4x	EMD 16-645E3B	GP-40, SD-40-2, SD-45-2
GP-50	EMD 16-645F3B	GP-50, SD-50M
GP-60	EMD 16-710G3A	GP-60, SD-60M
SD-7x	EMD 16-710G3B	SD-70MAC, SD-75
SD-90	EMD 16V265H	SD-90AC, SD-90-43AC
Dash-7	GE7FDL (12 cyl)	B23-7, B30-7, C36-7
Dash-8	GE7FDL (12 or 16 cyl)	B39-8, B40-8, C41-8
Dash-9	GE7FDL (16 cyl)	C44-9, C44AC
C60-A	GE7HDL	C60AC

Emission Factors and Fuel Effects

Figure 2 shows particulate matter (PM) emission factors for several of the more common locomotive model groups at the low to intermediate throttle settings typical of yard operations. As shown in the figure, emission rates generally increase with throttle setting. However, the older 3000 hp GP-4x series shows emissions comparable to (and in some cases, higher than) the newer 4000 to 4500 hp SD-7x and Dash-9 models. Due to the relatively large fraction of time locomotives spend at low throttle settings while in railyards, the relative differences in emission rates between models at these settings can significantly affect emissions estimates if locomotive model distributions change over time.

Figure 2. Locomotive PM Emission Factors (g/hr).

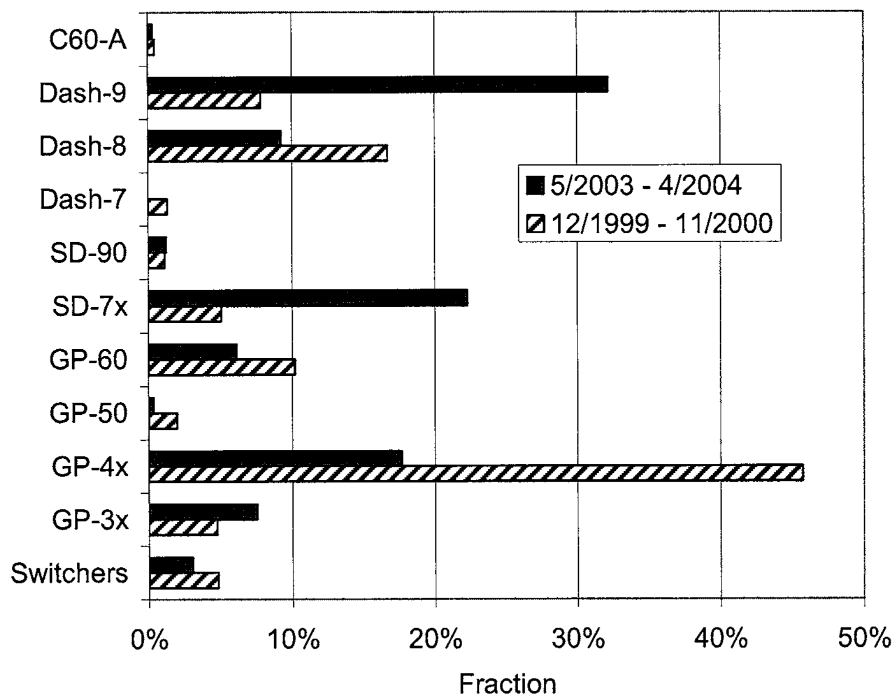


The emission factors used were based on tests using fuel typical of national off-road diesel. Initial emission estimates were derived by multiplying model-specific g/hr emission rates by the total hours of operation and locomotive model fraction for each activity within the yard. At the Davis Yard, over half of the diesel fuel dispensed to locomotives meets California on-road diesel fuel specifications (so-called "CARB diesel"). To account for the effect of fuel quality on emissions, estimates of the fraction of locally dispensed fuel burned by locomotives in different yard activities were developed. These ranged from 100 percent for hump and trim sets to zero percent for inbound line-haul units prior to refueling. These fractions were multiplied by the fraction of CARB diesel dispensed at the yard and an estimate of 14 percent reduction in PM emissions for locomotives burning CARB diesel to develop fuel effects adjustments for individual activities.

EMISSION TRENDS

Using the procedures described in the preceding sections, emissions estimates were developed for the December 1999 to November 2000 period, and the May 2003 to April 2004 period. During this period, significant changes in the UPRR locomotive fleet occurred, with the addition of new locomotives and the retirement of older units. Figure 3 shows the locomotive model distributions for all servicing events at the Davis Yard during these two periods. Service events include both the line-haul and local units arriving and departing on trains (which make up the bulk of these events), as well as the hump and trim sets. A significant increase in the relative fraction of high horsepower SD-7x and Dash-9 units is seen, and a corresponding decrease in the fraction of older GP-4x, GP-50, GP-60, Dash-7 and Dash-8 models. In addition to the fleet modernization, tabulations of specific emission control technologies on units serviced at the Davis Yard showed substantial penetration of new and retrofit technologies. Approximately 31 percent of locomotives serviced at the yard were equipped with computer-controlled shut-down and restart technology, resulting in reduced idling times. Also, approximately 27 percent of servicings were for Tier 0 locomotives, and approximately 25 percent were Tier 1 units. Although the Tier 0 and Tier 1 technologies are not expected to substantially reduce PM emissions, their nitrogen oxides emissions are lower. A few prototype Tier 2 units were observed in 2003 – 2004 data, and their reduced PM emissions will show benefits in the future.

Figure 3. Changes in Locomotive Model Distributions.



The freight volume passing through the yard also changed between these periods. Table 4 lists the percent change in the number of arriving and departing trains, locomotives, and trailing tons (a measure of freight volume). The number of trains and locomotives showed little change, however the trailing tons increased by approximately 15 percent, implying that the average train weight (and correspondingly, the required consist horsepower) increased. This is a result of the increased availability of high horsepower units in the UPRR fleet. A higher fraction of trains bypass the yard, either not stopping, or stopping only for crew changes.

Table 4. Percent Change in Yard Activity Levels from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Trains	Locomotives	Trailing Tons
Arrivals	-5.2%	-3.5%	--
Departures	-7.0%	-7.3%	--
Throughs (Bypassing the yard)	8.0%	6.8%	--
Total Arrivals and Departures	-0.3%	-0.9%	15.1%

The newer locomotive fleet also affected the level of load testing activity required. Table 5 lists the percent change in the number of load tests of different types, and the corresponding change in total locomotive testing time at idle, notch 1, and notch 8. The extended 30-minute post-maintenance tests were substantially reduced, and total hours of testing were reduced for the various throttle settings between 12 and 43 percent.

Table 5. Percent Change in Load Test Activity from 12/1999 – 11/2000 to 5/2003 – 4/2004.

10-Minute Tests	-18.9%
15-Minute Tests	14.6%
30-Minute Tests	-43.2%
Total Tests	-12.3%
Idling Hours	-20.6%
Notch 1 Hours	-43.2%
Notch 8 Hours	-12.0%

The combined net result of these changes is shown in Table 6. Between November 2000 and April 2003, total estimated PM emissions in the yard decreased by approximately 15 percent. Reductions in idling and movement emissions of about 20 percent were calculated, due to the combination of a newer, lower emitting locomotive fleet and the computer-controlled shutdown technologies (both retrofits and standard equipment on newer units). Hump and trim emissions were reduced by about 6 percent, and load testing emissions by about 14 percent.

Table 6. Emissions Changes from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Estimated Emissions (tons per year)		**Percent Change**
	12/1999 – 11/2000	**5/2003 – 4/2004**	
Idling and Movement of Trains	5.2	4.2	-20.3%
Idling and Movement of Consists	8.5	6.8	-20.2%
Testing	1.5	1.3	-14.1%
Hump and Trim	7.0	6.6	-5.7%
Total	22.3	18.9	-15.3%

CONCLUSIONS

Because of the unique features of each individual railyard, top-down methods (e.g., based only on tons of freight handled or number of arriving locomotives) cannot provide reliable estimates of railyard emissions. Yard-specific data are needed. In-yard activity patterns (and emissions) will vary between yards depending on factors such as: the type of yard (e.g., hump or flat switching classification yards, or intermodal facilities); the presence and capabilities of service tracks or locomotive repair shops; the types of freight handled; the location of the yard in the rail network; and yard configuration. The development of procedures for retrieving and analyzing activity data and locomotive characteristics for a specific railyard is a substantial improvement of alternatives based on top-down estimation. By obtaining disaggregate data for the range of specific activities occurring within railyards, it is possible to reliably estimate historical trends in emissions, as well as to evaluate the potential effects of operational changes and new technologies. Railyard operations cannot be treated in isolation, since these yards are only one component of complex national level systems. Nevertheless, the ability to assess the details of yard operations and their emissions provides an improved basis for environmental management decisions at both local and larger scales.

REFERENCES

1. Hand, R.; Di, P.; Servin, A.; Hunsaker, L.; Suer, C. *Roseville Rail Yard Study*, California Air Resources Board, Stationary Source Division, Sacramento, CA, October 14, 2004.

2. U. S. Environmental Protection Agency. *Locomotive Emission Standards – Regulatory Support Document*, U. S. Environmental Protection Agency, Office of Mobile Sources, April 1998.

3. Fritz, S. "Emissions Measurements – Locomotives", SwRI Project No. 08-5374-024, Prepared for the U.S. Environmental Protection Agency by Southwest Research Institute, San Antonio, TX, August 1995.

4. Fritz, S. "Diesel Fuel Effects on Locomotive Exhaust Emissions", SwRI Proposal No. 08-23088C, Prepared for the California Air Resources Board by Southwest Research Institute, San Antonio, TX, October 2000.

KEY WORDS

Emission inventories
Locomotives
Railyards
Diesel

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APPENDIX A-7

SULFUR ADJUSTMENT CALCULATIONS

Appendix A-7

Development of Adjustment Factors for Locomotive DPM Emissions Based on Sulfur Content

Wong (undated) provides equations for estimating g/bhp-hr emission rates for 4-Stroke (GE) and 2-Stroke (EMD) locomotives. Rather than using these statistically derived estimates for absolute emissions when model- and notch-specific emission factors are available, we used these equations to develop *relative* emission rate changes for different sulfur levels. The basic form of the equation is

$$q = a \cdot S + b$$

Where,

q is the predicted g/bhp-hr emission rate of a locomotive at a specific throttle setting and sulfur content;

a and b are coefficients specific to a locomotive type (2- or 4-stroke) and throttle notch; and

S is the fuel sulfur content in ppm.

Thus, to calculate the emission adjustment factor for a specific fuel sulfur content, it is necessary to calculate the nominal emission rate q_0 for the baseline fuel sulfur content S_0, and the emission rate q_i for the fuel of interest with sulfur content S_i. This adjustment factor k_i is simply

$$k_i = 1 - \frac{(q_0 - q_i)}{q_0},$$

Where, q_0 and q_i are calculated using the equation above. Tables 1 and 2 give the values of the a and b coefficients for 4-stroke and 2-stroke locomotives. For throttle settings below notch 3, sulfur content is not expected to affect emission rates. The baseline emission rates from which actual emissions are estimated were derived from emission tests of different locomotive models. Although full documentation of fuels is not available for all of these tests, they are assumed to be representative of actual emissions of the different models running on 3,000 ppm sulfur EPA non-road Diesel fuel. For the purposes of modeling 2005 emissions, these factors are needed to adjust the baseline emission factors to emission factors representative of two fuels – 221 ppm and 2639 ppm. Table 3 shows the resulting correction factors for these two fuels by notch and engine type. To generate locomotive model-, throttle-, tier-, and fuel-specific emission factors, the base case (nominal 3,000 ppm S) emission factors in Table 4 were multiplied by the corresponding correction factors for throttle settings between notch 3 and notch 8.

Table 1 Sulfur Correction Coefficients for 4-Stroke Engines		
Throttle Setting	***a***	***b***
Notch 8	0.00001308	0.0967
Notch 7	0.00001102	0.0845
Notch 6	0.00000654	0.1037
Notch 5	0.00000548	0.1320
Notch 4	0.00000663	0.1513
Notch 3	0.00000979	0.1565

Table 2 Sulfur Correction Coefficients for 2-Stroke Engines		
Throttle Setting	***a***	***b***
Notch 8	0.0000123	0.3563
Notch 7	0.0000096	0.2840
Notch 6	0.0000134	0.2843
Notch 5	0.0000150	0.2572
Notch 4	0.0000125	0.2629
Notch 3	0.0000065	0.2635

Table 3 DPM Emission Adjustment Factors for Different Fuel Sulfur Levels				
Throttle Setting	**4-Stroke (GE)**		**2-Stroke (EMD)**	
	2,639 ppm S	**221 ppm S**	**2,639 ppm S**	**221 ppm S**
Notch 8	0.9653	0.7326	0.9887	0.9131
Notch 7	0.9662	0.7395	0.9889	0.9147
Notch 6	0.9809	0.8526	0.9851	0.8852
Notch 5	0.9867	0.8974	0.9821	0.8621
Notch 4	0.9860	0.8924	0.9850	0.8844
Notch 3	0.9810	0.8536	0.9917	0.9362

Table 4
Base Case Locomotive Diesel Particulate Matter Emission Factors (g/hr)
(3,000 PPM Sulfur Assumed)

Model Group	Tier	Throttle Setting										Source
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	138.0	159.0	201.0	308.0	345.0	448.0	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	186.0	212.0	267.0	417.0	463.0	608.0	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	226.4	258.5	336.0	551.9	638.6	821.3	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	301.5	311.2	394.0	663.8	725.3	927.8	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	284.5	299.4	375.3	645.7	743.6	941.6	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	239.4	352.2	517.8	724.8	1125.9	1319.8	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	156.8	243.1	321.1	374.8	475.2	589.2	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	230.4	379.8	450.8	866.2	1019.1	1105.7	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	219.3	295.9	436.7	713.2	783.2	847.7	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	271.7	300.4	335.2	551.5	672.0	704.2	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	255.9	423.7	561.6	329.3	258.2	933.6	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	359.5	327.7	331.5	299.4	336.7	420.0	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	291.4	293.2	327.7	373.5	469.4	615.2	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	219.9	289.1	370.6	437.7	486.1	705.7	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	229.2	263.8	615.9	573.9	608.0	566.6	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	304.0	383.5	423.9	520.2	544.6	778.1	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	304.3	365.0	405.2	418.4	513.5	607.5	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	277.9	234.1	276.0	311.4	228.0	362.7	GE[4] (UP7555)

Notes:

1. EPA Regulatory Support Document, “Locomotive Emissions Regulation,” Appendix B, 12/17/97, as tabulated by ARB and ENVIRON
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report “Emissions Measurments – Locomotives” by Steve Fritz, August 1995.
4. Manufacturers’ emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer’s emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON..

OFFROAD Modeling Change Technical Memo

SUBJECT: Changes to the Locomotive Inventory

LEAD: Walter Wong

Summary

The statewide locomotive emission inventory has not been updated since 2002. Using the Booz-Allen Hamilton's (BAH) study (Locomotive Emission Study) published in 1992 as a guideline (summary of inventory methodology can be found in Appendix A), staff updated the locomotive inventory.

The history of locomotive emission inventory updates began in 1992 using the results from the BAH report as the baseline inventory. In 2003, staff began updating the emissions inventory by revising the growth assumptions used in the inventory. The revised growth factors were incorporated into the ARB's 2003 Almanac Emission Inventory. With additional data, staff is proposing further update to the locomotive inventory to incorporate fuel correction factors, add passenger train data and Class III locomotives. Changes from updated locomotive activity data have made a significant impact on the total inventory (see Table 1).

Table 1. Impact of Changes on Statewide Locomotive Inventory

	Pre 2003 ARB Almanac Inventory (tons/day)			Revised Inventory (tons/day)			Difference (tons/day)		
Year	HC	NOx	PM	HC	NOx	PM	HC	NOx	PM
1987	7.2	158.8	3.6	7.2	158.8	3.6	0.0	0.0	0.0
2000	7.2	144.8	2.8	9.8	207.2	4.7	2.6	62.4	1.9
2010	7.2	77.8	2.8	9.5	131.9	4.2	2.3	54.1	1.4
2020	7.2	77.8	2.8	9.4	134.6	4.1	2.2	56.8	1.3

Reasons For Change

During the 2003 South Coast's State Implementation Plan (SIP) development process, industry consultants approached Air Resources Board (ARB) staff to refine the locomotive emissions inventory. Specifically, their concerns were related to the growth factors and fuel correction factors used in the inventory calculations. This document outlines how the locomotive emissions inventory was updated and the subsequent changes made to address industry's concerns.

Background : Baseline 1987 Locomotive Emissions Inventory (BAH report)

Locomotive operations can be characterized by the type of service performed. For emission inventory purposes, locomotives are classified into five different service types as defined in BAH's report.

Line-haul/intermodal – Intermodal locomotives generally operate at higher speeds and with higher power than other types and incorporate modern, high-speed engines.

Mixed/bulk – Mixed locomotives are the most common and operate with a wide range of power. They also perform line-haul duties.

Local/Short Haul – Local locomotives perform services that are a mixture of mixed freight and yard service. They operate with lower power and use older horsepower engines.

Yard/Switcher – Yard operations are used in switching locomotives and characterized by stop and start type movements. They operate with smaller engines and have the oldest locomotive engines.

Passenger – Passenger locomotives are generally high speed line haul type operations.

Categories of railroads are further explained by a precise revenue-based definition found in the regulations of the Surface Transportation Board (STB). Rail carriers are grouped into three classes for the purposes of accounting and reporting:

Class I –Carriers with annual operating revenues of $250 million or more

Class II – Carriers with annual operating revenues of less than $250 million but in excess of $20 million

Class III – Carriers with annual operating revenues of less than $20 million or less, and all switching companies regardless of operating revenues.

The threshold figures are adjusted annually for inflation using the base year of 1991.

The 1987 locomotive inventory as shown in Table 2 is taken from the BAH report prepared for the ARB entitled "Locomotive Emission Study" completed in 1992 (http://www.arb.ca.gov/app/library/libcc.php). Information was gathered from many sources including ARB, the South Coast Air Quality Management District, the California Energy Commission, the Association of American Railroads (AAR), locomotive and large engine manufacturers, and Southwest Research Institute. Railroad companies, such as Southern Pacific, Union Pacific, and Atchison, Topeka and Santa Fe (ATSF), provided emission factors, train operation data, and throttle position profiles for trains operating in their respective territories. Southwest Research Institute provided emission test data.

Table 2. 1987 Locomotive Inventory in Tons Per Day, Statewide, BAH report

TYPE	HC	CO	NOX	PM	SOX
Line-Haul/Intermodal	3.97	12.89	86.21	1.97	6.36
Short-Haul/Local	0.96	3.06	21.30	0.46	1.59
Mixed	1.51	4.85	37.34	0.81	2.76
Passenger	0.10	0.22	3.24	0.07	0.30
Yard/Switcher	0.62	1.57	10.69	0.24	0.58
Total	7.16	22.59	158.78	3.55	11.59

The assumed average fuel sulfur content is 2700 parts per million (ppm) obtained from the BAH report.

Current Growth Estimates

Prior to the 2003 South Coast SIP update, growth factors were based on employment data in the railroad industry. Staff believes that the use of historic employment data, which translates to a decline in emissions in future years, may be masking actual positive growth in locomotive operations. It may be assumed that the number of employees is declining due to increased efficiency.

Changes to the Locomotive Inventory

Summary of Growth in Emission Based on BAH Report

Growth is estimated based on train operation type and by several operating characteristics.

Increased Rail Lube and Aerodynamics – this arises from reduction in friction and will help reduce power requirements.

Introduction of New Locomotives – older locomotive units will be replaced by newer models.

Changes in Traffic Level – the increase or decrease in railroad activity

In the BAH report, projected emission estimates for years 2000 and 2010 were based on the factors shown in Tables 3 and 4. A substantial part of the locomotive emission inventory forecast is based upon projections of rail traffic levels. BAH projected future rail traffic level as a function of population and economic growth in the state. BAH also projected growth in emission only to 2010.

Table 3. Changes in Emissions from 1987-2000 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (1987 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-7.0%	-8.0%	17.0%	2.0%
Mixed & Bulk	-7.0%	-8.0%	2.0%	-13.0%
Local	-3.0%	-3.0%	-2.0%	-8.0%
Yard	0.0%	-1.0%	-25.0%	-26.0%
Passenger	-7.0%	-8.0%	10.0%	-5.0%

Table 4. Changes in Emissions from 2001-2010 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (2000 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-2.0%	-3.0%	-8.0%	25.0%	12.0%
Mixed & Bulk	-2.0%	-3.0%	-8.0%	0.0%	-13.0%
Local	-1.0%	0.0%	-12.0%	-10.0%	-23.0%
Yard	0.0%	0.0%	-10.0%	-15.0%	-25.0%
Passenger	-2.0%	-3.0%	-8.0%	15.0%	2.0%

BAH added “Improved Dispatching and Train Control” to differentiate these impacts from the “Increased Rail Lubing” which helps to improve fuel efficiency from locomotive engines. Since train control techniques are emerging from the signal company research work, these assumed changes will not impact emission until year 2000.

Based on industry's input, staff recommends several changes to the locomotive emissions inventory. These include modifying growth factors, making adjustments to control factors reflecting the U. S. EPA regulations that went into effect in year 2000, incorporating fuel correction factors, adding smaller class III railroad and industrial locomotive, and updating passenger data.

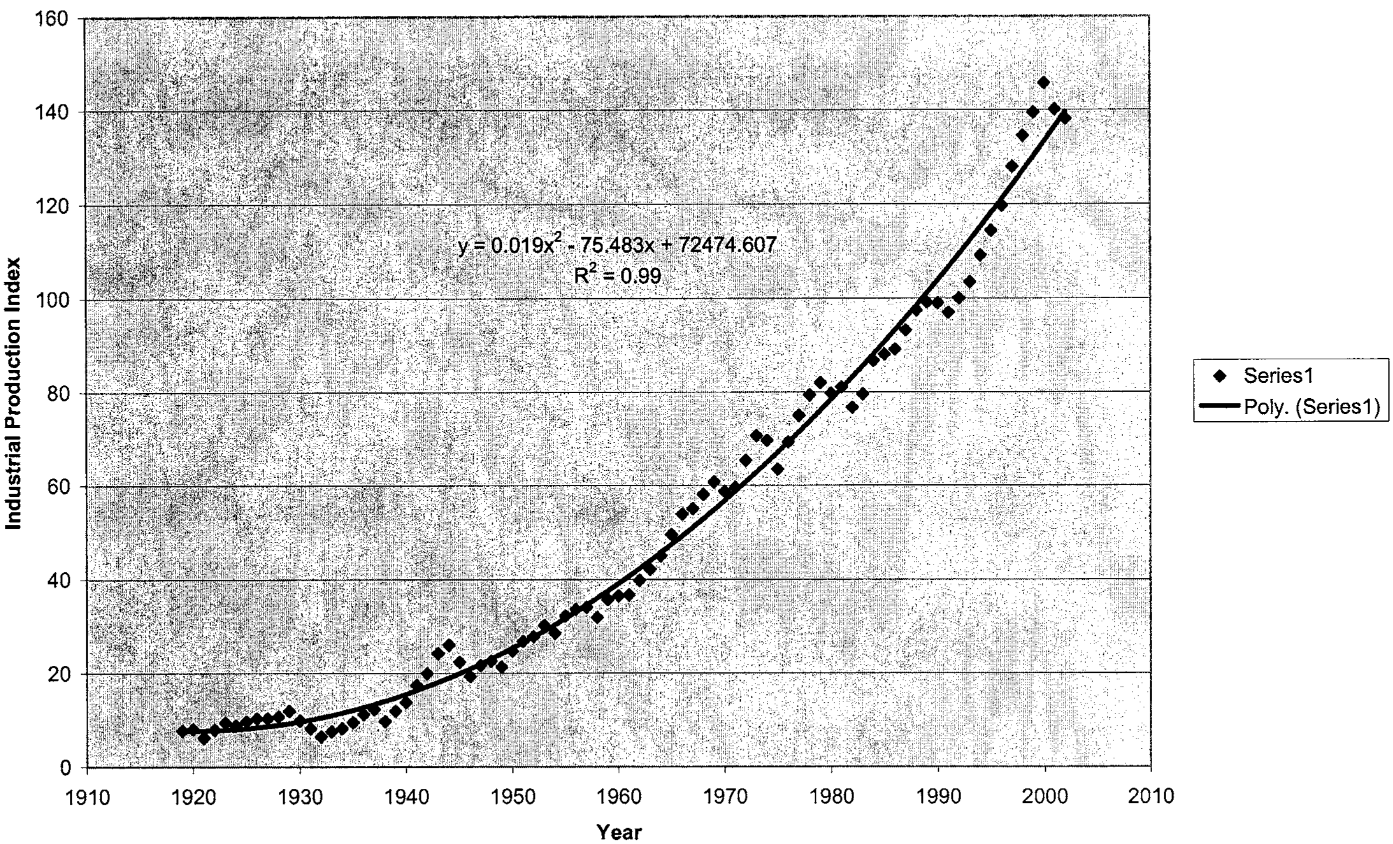
Revised Growth in Emissions

Staff revised the growth factors for locomotives based on new data that better reflect locomotive operations. This includes U.S. industrial production and various railroad statistics available from the AAR.

Based on historic data recently obtained from U.S. industrial productions and the AAR, the changes in traffic levels were revised. A better estimate for changes in traffic levels for locomotives can be made to the line-haul class of railroad, which are the intermodal and mixed and bulk type of locomotives, using industrial production and AAR's data.

Industrial production data is considered to be a surrogate for changes in traffic levels of the line-haul locomotive. It is assumed that railroad activity would increase in order to accommodate the need to move more product. Industrial production is the total output of U.S. factories and mines, and is a key economic indicator released monthly by the Federal Reserve Board. U.S. industrial production historical data from 1920 to 2002 was obtained and analyzed from government sources. Figure 1 shows the historical industrial production trend (Source : http://www.research.stlouisfed.org/fred2/series/INDPRO/3/Max). Statistical analysis was used to derive a polynomial equation to fit the data.

Figure 1. Long-term Industrial Production



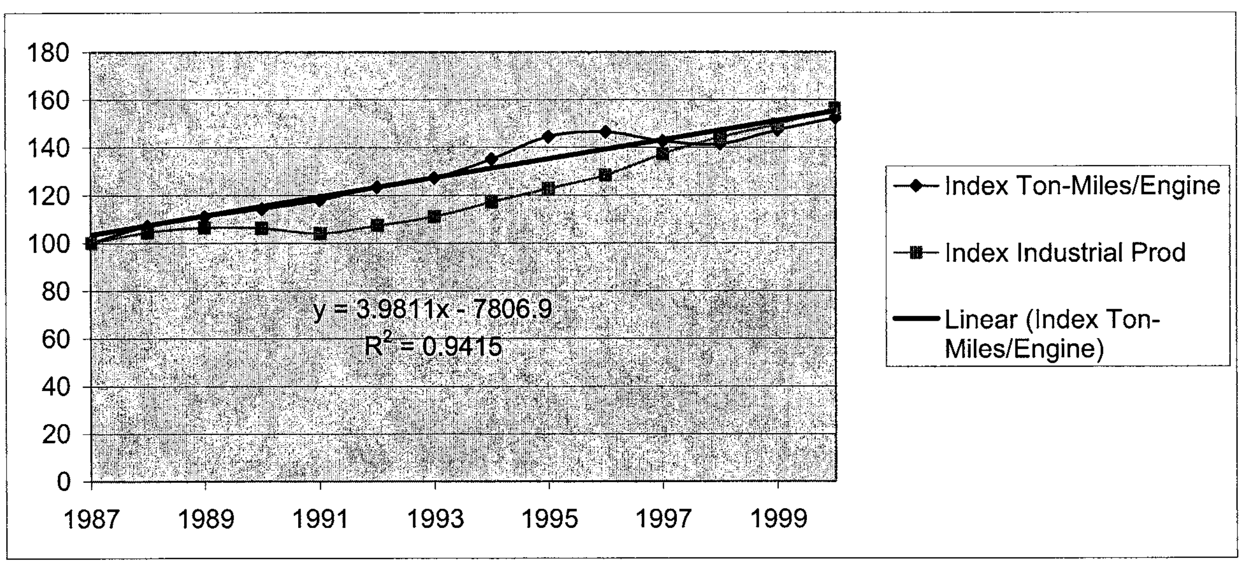
Another surrogate for growth is net ton-miles per engine. Consequently, staff analyzed railroad data from the AAR's Railroad Facts booklet (2001 edition). The booklet contains line-haul railroad statistics including financial status, operation and employment data, and usage profiles. Revenue ton-mile and locomotives in service data from the booklet were used to compute the net ton-miles per engine as shown in Table 5.

Table 5. Revenue Ton-Miles and Ton-Miles/Engine (AAR Railroad Facts 2001 edition)

Year	Locomotive Diesel in Service (US)	Revenue Ton-Miles	Ton-Miles/Engine
1987	19,647	943,747	48.04
1988	19,364	996,182	51.45
1989	19,015	1,013,841	53.32
1990	18,835	1,033,969	54.90
1991	18,344	1,038,875	56.63
1992	18,004	1,066,781	59.25
1993	18,161	1,109,309	61.08
1994	18,496	1,200,701	64.92
1995	18,810	1,305,688	69.41
1996	19,267	1,355,975	70.38
1997	19,682	1,348,926	68.54
1998	20,259	1,376,802	67.96
1999	20,254	1,433,461	70.77
2000	20,026	1,465,960	73.20

As shown in Figure 2, there is a relatively good correlation between net ton-miles per engine growth and industrial production. Because net ton-miles per engine data are compiled by the railroad industry and pertains directly to the railroad segment, staff believes that net ton-miles per engine will better characterize future traffic level changes.

Figure 2. Ton-miles/Engine vs. Industrial Production (index base year = 1987)



The ton-miles/engine data were projected to calculate the future growth rate of traffic level using a linear equation.

Staff also made changes to the "Increased Rail Lube and Aerodynamics" assumption shown in Tables 3 and 4. Rail lubing does not benefit the idling portion of locomotive activity. Since idling contributes 20% of the weighting in the line-haul duty cycle, staff reduced the rail lubing benefit by 20%. Meanwhile, improved dispatching and train control is assumed only to reduce engine idling. Therefore, staff reduced the improved dispatching benefit by 80%.

The benefit of the introduction of new locomotives to the fleet was decreased from the original BAH assumption. BAH assumed 50% penetration of the new engines by 2000. Literature research suggests that the new engines accounted for only about 34% of the fleet in 2000 (www.railwatch.com, http://utahrails.net/all-time/modern-index.php). These new engines are assumed to be 15% cleaner. Therefore, the benefit from new locomotive engines has been reduced to 5% (34% x 15% = 5% reduction).

Tables 6, 7, and 8 present the revised growth factors to be used to project the baseline (1987) locomotive emissions inventory into the future.

Table 6. ARB Revised Growth 1987-2000, ARB's 2003 Almanac Emission Inventory

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locos	Population Increase	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Mixed & Bulk	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Local	-2.4%	0%	0%	-2.0%	-4.4%	-0.35%
Yard	0.0%	0%	0%	-25.0%	-25.0%	-2.19%
Passenger	-5.6%	0%	1.9%	10.0%	6.3%	0.47%

The benefit of new locomotives with cleaner burning engines is accounted for in the control factor from EPA's regulation beginning in 2001, which takes into account introduction of new locomotive engines meeting Tier I and Tier II standards.

Table 7. ARB Revised Growth 2001-2010 (2000 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-1.6%	-0.6%	22.5%	20.3%	1.87%
Mixed & Bulk	-1.6%	-0.6%	22.5%	20.3%	1.87%
Local	-0.8%	-0.6%	-10.0%	-11.4%	-1.20%
Yard	0.0%	0.0%	-15.0%	-15.0%	-1.61%
Passenger	-1.6%	0.0%	15.0%	13.4%	1.27%

Table 8. ARB Revised Growth 2010-2020 (2010 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth	Annual Growth
Intermodal	0.0%	0.0%	18.0%	18.0%	1.67%
Mixed & Bulk	0.0%	0.0%	18.0%	18.0%	1.67%
Local	0.0%	0.0%	0.0%	0.0%	0.00%
Yard	0.0%	0.0%	0.0%	0.0%	0.00%
Passenger	0.0%	0.0%	0.0%	0.0%	0.00%

In Table 8, staff assumes no benefit from aerodynamics and improved train controls. Staff seeks guidance from industry as to their input regarding future benefits.

Table 9. Revised Growth in Emissions (Base Year 1987)

Year	Intermodal	Mixed & Bulk	Local	Yard	Passenger
1987	1.00	1.00	1.00	1.00	1.00
1988	1.03	1.03	1.00	0.98	1.00
1989	1.05	1.05	0.99	0.96	1.01
1990	1.08	1.08	0.99	0.94	1.01
1991	1.11	1.11	0.99	0.92	1.02
1992	1.14	1.14	0.98	0.90	1.02
1993	1.17	1.17	0.98	0.88	1.03
1994	1.20	1.20	0.98	0.86	1.03
1995	1.24	1.24	0.97	0.84	1.04
1996	1.27	1.27	0.97	0.82	1.04
1997	1.30	1.30	0.97	0.80	1.05
1998	1.34	1.34	0.96	0.78	1.05
1999	1.38	1.38	0.96	0.77	1.06
2000	1.41	1.41	0.96	0.75	1.06
2001	1.44	1.44	0.94	0.74	1.08
2002	1.47	1.47	0.93	0.73	1.09
2003	1.49	1.49	0.92	0.71	1.10
2004	1.52	1.52	0.91	0.70	1.12
2005	1.55	1.55	0.90	0.69	1.13
2006	1.58	1.58	0.89	0.68	1.15
2007	1.61	1.61	0.88	0.67	1.16
2008	1.64	1.64	0.87	0.66	1.18
2009	1.67	1.67	0.86	0.65	1.19
2010	1.70	1.70	0.85	0.64	1.21
2011	1.73	1.73	0.85	0.64	1.21
2012	1.76	1.76	0.85	0.64	1.21
2013	1.79	1.79	0.85	0.64	1.21
2014	1.81	1.81	0.85	0.64	1.21
2015	1.85	1.85	0.85	0.64	1.21
2016	1.88	1.88	0.85	0.64	1.21
2017	1.91	1.91	0.85	0.64	1.21
2018	1.94	1.94	0.85	0.64	1.21
2019	1.97	1.97	0.85	0.64	1.21
2020	2.00	2.00	0.85	0.64	1.21

Control Factors for U.S. EPA regulation

In December 1997, the U.S. EPA finalized the locomotive emission standard regulation. The regulatory support document lists the control factors used (http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf). Staff modified the control factors to incorporate the existing memorandum of understanding (http://www.arb.ca.gov/msprog/offroad/loco/loco.htm) between the South Coast AQMD and the railroads that operate in the region. Previously, one control factor was applied statewide. In the revised emissions inventory starting in 2010, a lower control factor reflecting the introduction of lower emitting locomotive engines in the SCAB region was applied. Tables 10 and 11 show the revised control factors. Road hauling definition as used by U.S. EPA applies to the line-haul/intermodal, mixed, and local/short haul train type in the emissions inventory.

Table 10. Revised Statewide Control Factors

Year	State Road Hauling HC	State Road Hauling NOx	State Road Hauling PM	State Switcher HC	State Switcher NOx	State Switcher PM	State Passenger HC	State Passenger NOx	State Passenger PM
1999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00	1.00	0.96	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00	1.00	0.94	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99	0.98	0.92	0.98
2006	0.92	0.62	0.92	0.99	0.91	0.99	0.96	0.90	0.96
2007	0.89	0.59	0.89	0.98	0.89	0.98	0.94	0.83	0.94
2008	0.87	0.57	0.86	0.98	0.87	0.97	0.92	0.76	0.92
2009	0.84	0.55	0.84	0.97	0.85	0.97	0.91	0.69	0.90
2010	0.82	0.54	0.81	0.96	0.83	0.96	0.89	0.62	0.88
2011	0.81	0.53	0.80	0.96	0.81	0.95	0.87	0.57	0.87
2012	0.80	0.53	0.79	0.95	0.79	0.94	0.85	0.56	0.85
2013	0.79	0.52	0.78	0.94	0.77	0.93	0.83	0.54	0.83
2014	0.77	0.51	0.76	0.94	0.75	0.93	0.82	0.53	0.81
2015	0.76	0.50	0.75	0.93	0.73	0.92	0.80	0.52	0.79
2016	0.75	0.50	0.74	0.92	0.71	0.91	0.78	0.51	0.77
2017	0.74	0.49	0.72	0.91	0.70	0.90	0.76	0.50	0.75
2018	0.73	0.48	0.71	0.90	0.69	0.89	0.74	0.49	0.73
2019	0.71	0.48	0.70	0.89	0.68	0.88	0.73	0.48	0.71
2020+	0.70	0.47	0.69	0.89	0.67	0.87	0.71	0.47	0.69

Table 11. Revised SCAB Control Factors

Year	SCAB Road Hauling HC	SCAB Road Hauling NOx	SCAB Road Hauling PM	SCAB Switcher HC	SCAB Switcher NOx	SCAB Switcher PM
1999	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99
2006	0.92	0.62	0.92	0.99	0.91	0.99
2007	0.89	0.59	0.89	0.98	0.89	0.98
2008	0.87	0.57	0.86	0.98	0.87	0.97
2009	0.84	0.55	0.84	0.97	0.85	0.97
2010	0.82	0.36	0.81	0.96	0.36	0.96
2011	0.81	0.36	0.80	0.96	0.36	0.95
2012	0.80	0.36	0.79	0.95	0.36	0.94
2013	0.79	0.36	0.78	0.94	0.36	0.93
2014	0.77	0.36	0.76	0.94	0.36	0.93
2015	0.76	0.36	0.75	0.93	0.36	0.92
2016	0.75	0.36	0.74	0.92	0.36	0.91
2017	0.74	0.36	0.72	0.91	0.36	0.90
2018	0.73	0.36	0.71	0.90	0.36	0.89
2019	0.71	0.36	0.70	0.89	0.36	0.88
2020+	0.70	0.36	0.69	0.89	0.36	0.87

Addition of Class III Locomotive and Industrial/Military Locomotive

The annual hours operated by the class III railroads are shown in Table 12. The results were tabulated from ARB Stationary Source Division's (SSD) survey (http://www.arb.ca.gov/regact/carblohc/carblohc.htm) conducted to support regulation with regards to ARB ultra-clean diesel fuel.

Table 12. Short-Haul and Switcher Annual Hours for Class III Railroads

Air Basin	Operations	Population	Annual Hours Operated
Mountain Counties	SW	2	10214
Mojave Desert	L	10	27440
North Coast	L	3	5700
North Central Coast	L	1	1332
	SW	3	3996
Northeast Plateau	L	5	9892
South Coast	SW	21	75379
South Central Coast	L	5	3200
San Diego	L	4	5000
San Francisco	L	8	31600
	SW	4	5059
San Joaquin Valley	L	29	68780
	SW	19	72248
Sacramento Valley	L	6	11400
Total		120	331240

L = local short-haul, SW = switcher

The short-haul and switcher emission rate are derived from BAH report. The report cites studies from testing done at EPA and Southwest Research Institute.

Table 13. Short-Haul and Switcher Emission Rate

Emission Rate	Short-Haul (g/bhp-hr)	Switcher (g/bhp-hr)
HC	0.38	0.44
CO	1.61	1.45
NOx	12.86	15.82
PM	0.26	0.28
SOx	0.89	0.90
Fuel Rate (lb/hr)	120.00	60.00

Table 14. Statewide Summary of Industrial Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	9	1,138	56
Others	11	587	54
San Francisco	11	525	54
San Joaquin Valley	38	1,176	54
South Coast	24	1,290	55
TOTALS	93	1,055	55

Table 15. Statewide Summary of Military Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	7	900	50
Northeast Plateau	2	1,850	50
Sacramento Valley	1	500	50
San Diego	7	835	50
San Francisco	4	1525	47.5
San Joaquin Valley	2	400	50
South Central Coast	1	500	50
TOTALS	24	930	49.6

The data from the survey provides a reasonable depiction of railroad activities in 2003. To forecast and backcast, an assumption was made to keep the data constant and have no growth. More research is needed to quantify the growth projections of smaller, local railroad activities.

Update to Passenger Trains

ARB's survey of intrastate locomotives included passenger agency trains that operated within the state. Staff attempted to reconcile the survey results by calculating the operation schedules posted by the operating agency to obtain hours of operation and mileage information. The results of the survey and calculated operating hours were comparable. Table 16 lists the calculated annual hours operated and miles traveled used to estimate emissions.

Table 16. Passenger Trains Annual Miles and Hours

Air Basin	Annual Miles Operated	Annual Hours Operated
South Coast	3,700,795	92,392
South Central Coast	151,864	4,020
San Diego	914,893	25,278
San Francisco	2,578,862	77,944
San Joaquin Valley	674,824	17,313
Sacramento Valley	635,384	20,058
Total	8,656,621	237,006

The passenger train emission rate is derived from testing done at SWRI on several passenger locomotives.

Table 17. Passenger Train Emission Rate

Emission Rate	Passenger Train (g/bhp-hr)
HC	0.50
CO	0.69
Nox	12.83
PM	0.36
Sox	0.90
Fuel Rate (lb/hr)	455.00

Fuel Correction Factors

Aromatics

Previous studies quantifying the effects of lowering aromatic content are listed in Table 18. These studies tested four-stroke heavy-duty diesel engines (HDD). Although staff would have preferred to analyze data from tests performed on various locomotive engines to determine the effects of lower aromatics, these HDD tests are the best available resources to determine the fuel corrections factors due to lower aromatics.

Table 18. Effect of Lowering Aromatic Volume on PM Emission

STUDY	**Sulfur (ppm)**	**Aromatics (Volume %)**	**PM Reduction (%)**
Chevron (1984)	2,800	31	Baseline
Chevron (1984)	500	31	23.8
Chevron (1984)	500	20	32.2
Chevron (1984)	500	15	36.0
Chevron (1984)	500	10	39.9
CRC-SWRI (1988)	500	31	Baseline
CRC-SWRI (1988)	500	20	9
CRC-SWRI (1988)	500	15	13
CRC-SWRI (1988)	500	10	17

Source : http://www.arb.ca.gov/fuels/diesel/diesel.htm

Using a linear regression of the data from the Table 18, the PM reduction from a change in aromatic content can be described as :

<u>4-Stroke Engine</u>
PM reduction = [(Difference in Aromatic Volume) * 0.785 + 0.05666]/100

For 2-Stroke engines, staff used test data from SWRI's report published in 2000 entitled "Diesel Fuel Effects on Locomotive Exhaust Emissions" to estimate indirectly the potential PM reduction for 2-Stroke engines due to lower aromatics. Table 19 lists the summary of the test results.

Table 19. SWRI 2000 Study Summary Results

Locomotive Engine	Aromatic Changes (Volume %)	PM Difference (g/bhp-hr)	PM % Difference
4 Stroke	28.35 to 21.84	0.080	37.6%
2 Stroke	28.35 to 21.84	0.056	14.1%

Staff assumes that PM emission reduction from 2-Stroke engine will have a factor of 0.38 (14.1%/37.6%) to the 4-Stroke engine PM emission reduction.

Currently, the baseline locomotive emissions inventory assumes an aromatic total volume percent of 31%. Table 21 describes the changes in PM emission due to changes in total volume percent of aromatics.

Table 20. Examples of PM Reductions Due to Changes in Aromatic Total Volume Percent

Aromatic Volume Percent		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
31	28	0.9%	2.4%	1.3%
31	19	3.6%	9.5%	5.1%
31	10	6.3%	16.5%	8.9%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Table 21,Table 22, and Table 23 show the PM emission reduction for the different type of fuels used in the state.

Table 21. PM Emission Percent Change of Line-Haul Due to Aromatics, Statewide

Calendar Year	CARB Aromatic Volume (%)	EPA Aromatic Volume (%)	Off-road Aromatic Volume (%)	Weighted Aromatic Volume (%)	PM Emission Percent Change
1992	31	31	31	31.00	0.00
1993	10	31	31	31.00	0.00
1994	10	31	31	31.00	0.00
1995	10	31	31	31.00	0.00
1996	10	31	31	31.00	0.00
1997	10	31	31	31.00	0.00
1998-2001	10	31	31	30.18	-0.004
2002-2006	10	31	31	29.05	-0.009
2007+	10	31	31	29.05	-0.009

Table 22. Class I Line Haul Weighted Aromatic Volume Percent by Air Basin

Interstate Locomotive	Air Basin	1993-2001 Weighted Aromatic	2002+ Weighted Aromatic
		Volume Percent	Volume Percent
Class I Line Haul	SCC	31.0	31.0
	MC	31.0	26.6
	MD	30.0	29.8
	NEP	31.0	27.9
	SC	31.0	31.0
	SF	28.6	23.1
	SJV	29.1	29.4
	SS	31.0	31.0
	SV	31.0	27.4

Table 23. PM Emission Reduction from Intrastate Locomotives Due to Aromatics by Air Basin, 1993+

Intrastate Locomotive	Air Basin	CARB Aromatic Volume Percent	EPA Aromatic Volume Percent	Nonroad Aromatic Volume Percent	Weighted Aromatic Volume Percent	PM Emission Reduction Percent
Class I Local/Switcher	SC	10	31	31	29.0	-0.9%
	SJV	10	31	31	25.2	-2.4%
	MD	10	31	31	31.0	0.0%
	BA	10	31	31	13.9	-7.2%
	SD	10	31	31	13.2	-7.5%
	SV	10	31	31	13.2	-7.5%
	SCC	10	31	31	13.2	-7.5%
Class III Local/Switcher	SC	10	31	31	31.0	0.0%
	SJV	10	31	31	18.6	-5.2%
	MD	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	10.0	-8.8%
	NEP	10	31	31	26.6	-1.9%
	MC	10	31	31	31.0	0.0%
	NC	10	31	31	10.0	-8.8%
	NCC	10	31	31	10.0	-8.8%
Industrial/Military	SC	10	31	31	24.0	-3.0%
	SJV	10	31	31	24.0	-3.0%
	MD	10	31	31	24.0	-3.0%
	BA	10	31	31	24.0	-3.0%
	NEP	10	31	31	24.0	-3.0%
	SD	10	31	31	24.0	-3.0%
	SV	10	31	31	24.0	-3.0%
	SCC	10	31	31	24.0	-3.0%
Passenger	SC	10	31	31	10.8	-8.5%
	SJV	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	12.1	-8.0%

Source : Fuel Estimate from http://www.arb.ca.gov/regact/carblohc/carblohc.htm

Sulfur

Currently, the baseline locomotive emissions inventory assumes an average fuel sulfur content of 2700 ppm. Industry has provided information on the sulfur content of the fuel that is currently being used by intrastate locomotives. Together with industry data and prior locomotive tests, staff believes a fuel correction factor should be incorporated into the model.

Table 24 shows the test data collected by the ARB, U.S. EPA, and others, where locomotive engines were tested on different fuel sulfur levels.

Table 24. Locomotive Engine Test with Different Sulfur Levels

Locomotive Engine	Fuel Properties Sulfur Content	Percent Change PM	Percent Change NOX	Percent Change CO	Percent Change HC	Source
EMD 12-645E3B	100/3300ppm	-0.29	-0.06	0.17	0.07	Fritz, 1991
GE DASH9-40C	330/3150ppm	-0.43	-0.07	-0.05	-0.18	Fritz (1995, EPA/SWRI)
MK 5000C	330/3150ppm	-0.71	-0.03	-0.03	-0.07	Fritz (1995, EPA/SWRI)
EMD 16-710G3B, SD70MAC	330/3150ppm	-0.38	-0.08	-0.30	-0.01	Fritz (1995, EPA/SWRI)
EMD SD70MAC	50/330ppm	-0.03	-0.04	0.07	0.01	Fritz (ARB/AAR, 2000)
EMD SD70MAC	50/4760ppm	-0.16	-0.06	0.08	0.03	Fritz (ARB/AAR, 2000)
EMD SD70MAC	330/4760ppm	-0.13	-0.03	0.01	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/330ppm	-0.03	-0.03	-0.01	-0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/4760ppm	-0.39	-0.07	-0.02	0.02	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/4760ppm	-0.38	-0.04	-0.02	0.06	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/3190ppm	-0.27	-0.05	-0.03	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/3190ppm	-0.25	-0.02	-0.02	0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	3190/4760ppm	-0.17	-.02	0.00	0.02	Fritz (ARB/AAR, 2000)
Average		-0.28	-0.05	-0.01	0.00	

From the above table, staff concluded that HC and CO emissions are not affected by different sulfur levels in the fuel. From these tests, staff computed the changes in PM emissions associated with changes in sulfur level. Staff corrected the PM emissions to account for the aromatic differences because the test data were not tested at the same aromatic volume percent. Because the locomotive engine testing was performed at various fuel sulfur levels (some at 330 ppm vs. 3190 ppm and some at 50 ppm vs. 3190 ppm), staff cannot assume the average percent change in PM emission is characteristics over the whole range of sulfur levels. From previous studies that staff has analyzed, it is possible to generate estimates of the percent change at various sulfur levels and throttle positions. Locomotive engines have 8 throttle positions plus dynamic braking and idle. During idle, braking, and throttle positions 1 and 2, there are no significant differences in emissions attributable to sulfur level. For the GE 4-

stroke engine, effect of sulfur on PM for throttle positions 3 to 8 can be defined by using the following equations:

Equations to correct for PM for GE (4-Stroke) engines

Notch 8 : PM (g/bhp-hr) = 0.00001308 * (sulfur level,ppm) + 0.0967
Notch 7 : PM (g/bhp-hr) = 0.00001102 * (sulfur level,ppm) + 0.0845
Notch 6 : PM (g/bhp-hr) = 0.00000654 * (sulfur level,ppm) + 0.1037
Notch 5 : PM (g/bhp-hr) = 0.00000548 * (sulfur level,ppm) + 0.1320
Notch 4 : PM (g/bhp-hr) = 0.00000663 * (sulfur level,ppm) + 0.1513
Notch 3 : PM (g/bhp-hr) = 0.00000979 * (sulfur level,ppm) + 0.1565

For the EMD 2-stroke engine, throttle positions 3 to 8 can be defined by using the following equations:

Equations to correct for PM for EMD (2-Stroke) engines

Notch 8 : PM (g/bhp-hr) = 0.0000123 * (sulfur level,ppm) + 0.3563
Notch 7 : PM (g/bhp-hr) = 0.0000096 * (sulfur level,ppm) + 0.2840
Notch 6 : PM (g/bhp-hr) = 0.0000134 * (sulfur level,ppm) + 0.2843
Notch 5 : PM (g/bhp-hr) = 0.0000150 * (sulfur level,ppm) + 0.2572
Notch 4 : PM (g/bhp-hr) = 0.0000125 * (sulfur level,ppm) + 0.2629
Notch 3 : PM (g/bhp-hr) = 0.0000065 * (sulfur level,ppm) + 0.2635

Table 25. Examples of PM Reductions Due to Changes in Sulfur Level

Sulfur Level (ppm)		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
3100	1900	4.1%	8.4%	5.2%
3100	1300	6.1%	12.6%	7.7%
1300	330	3.5%	7.9%	4.6%
1300	140	4.2%	9.5%	5.5%
140	15	1.8%	4.0%	2.4%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Data provided by industry show that when operating in California, the three main types of diesel fuel used in locomotive engines consists of CARB diesel, EPA On-Highway diesel fuel, and EPA Off-road or High Sulfur diesel fuel. Four-stroke engines and two-stroke engines show different characteristics with respect to sulfur content. From the BAH report, 4-stroke engines make up about 25%, and 2-stroke engines make up about 75% of the locomotive engine fleet. Combining industry data, 4-stroke/2-stroke engine percent change and fleet makeup, Table 26 shows the percent change in PM emissions by year for the line-haul segment of the fleet.

Table 26. PM Emission Percent Change of Line-Haul Due to Sulfur, Statewide

Calendar Year	CARB Sulfur Content	EPA On-Highway Sulfur Content	EPA Off-road Sulfur Content	Weighted Fuel Sulfur Content	4-Stroke Engines PM Percent Change	2-Stroke Engines PM Percent Change	Weighted PM Emission Percent Change
1992	3100	3100	3100	3100	0.03	0.01	0.015
1993	500	330	3100	2919	0.02	0.01	0.009
1994	150	330	3100	2740	0.01	0.00	0.003
1995	140	330	3100	2557	-0.01	0.00	-0.006
1996	140	330	3100	2377	-0.02	-0.01	-0.014
1997	140	330	3100	2196	-0.04	-0.02	-0.022
1998-2001	140	330	3100	1899	-0.06	-0.03	-0.035
2002-2006	140	330	3100	1312	-0.10	-0.05	-0.061
2007+	15	15	330	129	-0.19	-0.09	-0.113

Table 27 and Table 28 provide further details of weighted fuel sulfur level by air basin. Weighted sulfur levels vary significantly from one air basin to another.

Table 27. Class I Line Haul Weighted Fuel Sulfur by Air Basin

Interstate Locomotive	Air Basin	1998 Weighted Sulfur	2002-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Line Haul	SCC	1023	467	31
	MC	2333	1149	113
	MD	2352	1767	180
	NEP	2560	1632	166
	SC	1985	1472	145
	SF	1711	899	88
	SJV	1600	868	78
	SS	2425	1328	129
	SV	2473	1456	147

Table 28. Intrastate Locomotives Weighted Fuel Sulfur by Air Basin

Intrastate Locomotive	Air Basin	1993 Weighted Sulfur	1994-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Local/Switcher	SC	346	312	15
	SJV	377	278	15
	MD	330	330	15
	BA	468	175	15
	SD	475	169	15
	SV	475	169	15
	SCC	475	169	15
Class III Local/Switcher	SC	388	388	21
	SJV	1016	804	80
	MD	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	500	140	15
	NEP	2628	2553	264
	MC	1573	1573	152
	NC	500	140	15
	NCC	500	140	15
Industrial/Military	SC	1340	1220	120
	SJV	1340	1220	120
	MD	1340	1220	120
	BA	1340	1220	120
	NEP	1340	1220	120
	SD	1340	1220	120
	SV	1340	1220	120
	SCC	1340	1220	120
Passenger	SC	493	147	15
	SJV	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	483	159	15

Appendix B,C, and D contains the fuel correction factors for PM, NOx, and SOx emissions by air basin.

Revised Locomotive Emission Inventory

Tables 29-31 shows the revised locomotive emission inventory for calendar years 2000,2010 and 2020.

Table 29. 2000 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.61	18.21	113.03	2.68	6.22
Local/Short-Run	1.01	3.33	22.58	0.41	0.22
Mixed/Bulk	2.13	6.85	48.95	1.09	2.20
Passenger/Amtrak	0.53	1.01	12.21	0.29	0.05
Yard/Switcher	0.55	1.46	10.43	0.20	0.09
Total	9.83	30.86	207.20	4.67	8.78

Table 30. 2010 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.56	21.90	71.35	2.40	0.60
Local/Short-Run	0.77	2.99	12.03	0.30	0.01
Mixed/Bulk	2.11	8.24	29.46	0.99	0.19
Passenger/Amtrak	0.58	1.14	12.29	0.31	0.02
Yard/Switcher	0.47	1.29	6.78	0.17	0.01
Total	9.49	35.56	131.91	4.17	0.83

Table 31. 2020 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.60	25.84	74.33	2.38	0.71
Local/Short-Run	0.67	2.99	11.17	0.26	0.01
Mixed/Bulk	2.13	9.72	31.14	0.98	0.23
Passenger/Amtrak	0.56	1.14	11.72	0.30	0.02
Yard/Switcher	0.44	1.29	6.22	0.16	0.01
Total	9.40	40.98	134.58	4.08	0.98

Appendix A

Methodology to Calculate Locomotive Inventory

Methodology

The methodology and assumptions used for estimating locomotive emissions consists of several steps taken from the Booz-Allen Hamilton's Locomotive Emission Study report (http://www.arb.ca.gov/app/library/libcc.php). First, emission factor data from various engine manufacturers such as EMD and General Electric (GE) must be gathered to calculate average emission factors for locomotives operated by the railroad companies. Second, train operations data, including throttle position profiles and time spent on various types of operations from different railroad companies needs to be estimated. Finally, the locomotive emission inventory can be calculated using train operations data, emission factors, and throttle position profiles.

Step 1 – Average Emission Factors

Engine emission factors are required for the different locomotive engines manufactured by the major locomotive suppliers EMD or GE. Emission factors are obtained from testing done by either the engine manufacturers or by Southwest Research Institute, a consulting company that has performed many tests on locomotive engines. Table A-1 lists the available emission factors.

Table A-1. Available Emission Factors for Different Locomotive Engines

Engine Manufacturer	Engine Model	Locomotive Model
EMD	12-567BC	SW10
EMD	12-645E	SW1500,MP15,GP15-1
EMD	16-567C	GP9
EMD	16-645E	GP38,GP38-2, GP28
EMD	12-645E3B	GP39-2
EMD	12-645E3	GP39-2, SD39
EMD	16-645E3	GP40, SD40, F40PH
EMD	16-645E3B	GP40-2, SD40-2, SDF40-2, F40PH
EMD	16-645F3	GP40X, GP50, SD45
EMD	16-645F3B	SD50
EMD	20-645E3	SD45,SD45-2, F45, FP45
EMD	16-710G3	GP60, SD60, SD60M
GE	127FDL2500	B23-7
GE	127FDL3000	SF30B
GE	167FDL3000	C30-7, SF30C
GE	167FDL4000	B40-8

Source: BAH report, 1992

Next, the locomotive roster from the largest railroad companies operating in the state were obtained. Table A-2 lists the locomotive roster for railroad companies in 1987.

Table A-2. Locomotive Roster 1987

					Type of Service		
Railroad Company	Engine Manufacturer	Engine Model	Horspower Rating	Units	Line Haul	Local	Yard/Switcher
ATSF	EMD	16-567BC	1500	211			X
ATSF	EMD	16-567C	1750	53			X
ATSF	EMD	16-567D2	2000	71		X	X
ATSF	EMD	16-645E	2000	69		X	X
ATSF	EMD	12-645E3	2300	62		X	
ATSF	EMD	12-645E3B	2300	60		X	
ATSF	EMD	16-645E3	2500	231	X	X	
ATSF	EMD	16-645E3	3000	18	X	X	
ATSF	EMD	16-645E3B	3000	203	X	X	
ATSF	EMD	16-645F3	3500	52	X		
ATSF	EMD	16-645F3B	3600	15	X		
ATSF	EMD	20-645E3	3600	243	X		
ATSF	EMD	16-710G3	3800	20	X		
ATSF	GE	GE-12	2350	60		X	
ATSF	GE	GE-12	3000	10	X	X	
ATSF	GE	GE-16	3000	226	X	X	

ATSF	GE	GE-16	3600	43	X		
ATSF	GE	GE-16	3900	3	X		
ATSF	GE	GE-16	4000	20	X		
Union Pacific	EMD	16-645BC	1200	56			X
Union Pacific	EMD	12-567A	1200	12			X
Union Pacific	EMD	12-645E	1500	281			X
Union Pacific	EMD	16-567CE	1500	35			X
Union Pacific	EMD	16-645E	2000	365		X	X
Union Pacific	EMD	12-645E3C	2300	24		X	
Union Pacific	EMD	16-567D3A	2500	16		X	
Union Pacific	EMD	16-645E3	3000	828	X	X	
Union Pacific	EMD	16-645E3B	3000	446	X	X	
Union Pacific	EMD	16-645F3	3500	36	X		
Union Pacific	EMD	16-645F3B	3600	60	X		
Union Pacific	EMD	16-710G3	3800	227	X		
Union Pacific	GE	GE-12	2300	106		X	
Union Pacific	GE	GE-12	3000	57	X	X	
Union Pacific	GE	GE-16	3000	156	X	X	
Union Pacific	GE	GE-16	3750	60	X		
Union Pacific	GE	GE-16	3800	256	X		
Southern Pacific	EMD	12-567C	1200	11			X
Southern Pacific	EMD	12-645E	1500	286			X
Southern Pacific	EMD	16-567BC	1500	37			X
Southern Pacific	EMD	16-567C	1750	326		X	
Southern Pacific	EMD	16-567D2	2000	145		X	
Southern Pacific	EMD	16-645E	2000	84		X	
Southern Pacific	EMD	12-645E3	2300	12		X	
Southern Pacific	EMD	16-645E3	2500	137	X	X	
Southern Pacific	EMD	16-645E3	3000	92	X		
Southern Pacific	EMD	16-645E3B	3000	353	X		
Southern Pacific	EMD	16-645F3	3500	4	X		
Southern Pacific	EMD	20-645E3	3600	425	X		
Southern Pacific	EMD	16-710G3	3800	65	X		
Southern Pacific	GE	GE-12	2300	15		X	
Southern Pacific	GE	GE-12	3000	107	X		
Southern Pacific	GE	GE-16	3600	20	X		
Southern Pacific	GE	GE-16	3900	92	X		

Source : BAH report, 1992

Using the available emission factors and the locomotive rosters, the average emission factors for each class of service can be calculated. Emission factors for models that were not available were assigned an emission factor based on horsepower rating and the number of cylinders from similar engine models.

Step 2 – Throttle Position Profiles and Train Operations Data

The railroad companies provided throttle position profiles. Locomotive engines operate at eight different constant loads and speeds called throttle notches. In addition, several other settings (idle and dynamic brake) are also common. For line haul and local operations, profiles were obtained from Train Performance Calculation (TPC) data and actual event recorder data, which are summarized in the BAH report.

For line haul operations, the data was modified to account for additional idle time between dispatch. Data supplied by Atchison, Topeka and Santa Fe (ATSF) indicates that the turnaround time for line haul locomotives in yards is approximately eight hours.

For local operations, several assumptions were used to develop throttle profiles. First, ten hours was used as an average hours per assignment. Second, the additional average idle time per day per locomotive was assumed to be ten hours.

The switch engine duty cycle is based upon actual tape data supplied by the ATSF railroad company on a switch engine that operated over a 2-day period. Yard engines are assumed to operate 350 days per year, with 2 weeks off for inspections and maintenance.

Train operations data provided by the railroad companies included :

Line Haul	Local	Yard/Switcher
Train type	Average trailing tons	Number of units assigned
Number of runs per year	Number of runs per year	Number of assignments
Average horsepower	Average horsepower	Average horsepower
Average units	Average units	
Origin/destination	Origin/destination	
Link miles		

Step 3 – Calculate Locomotive Emission Inventory

Emission inventories are calculated on a train-by-train basis using train operations data, average emission factor, and throttle position profiles.

Emission Inventory = Emission factor x average horsepower x time in notch per train x number of runs per year

Appendix B
PM Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	PM Fuel Correction Factor pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.991	0.982	0.973	0.964	0.955	0.937	0.931	0.925	0.919	0.913	0.913	0.913	0.913	0.913	0.883
	MC	1.000	0.998	0.996	0.994	0.992	0.990	0.987	0.971	0.955	0.939	0.923	0.923	0.923	0.923	0.923	0.867
	MD	1.000	0.998	0.995	0.993	0.991	0.988	0.984	0.978	0.973	0.967	0.962	0.962	0.962	0.962	0.962	0.884
	NEP	1.000	0.999	0.998	0.998	0.997	0.996	0.995	0.983	0.971	0.959	0.947	0.947	0.947	0.947	0.947	0.875
	SC	1.000	0.996	0.993	0.989	0.986	0.982	0.975	0.970	0.965	0.960	0.955	0.955	0.955	0.955	0.955	0.888
	SF	1.000	0.993	0.987	0.980	0.974	0.967	0.954	0.940	0.926	0.912	0.898	0.898	0.898	0.898	0.898	0.851
	SJV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.944	0.937	0.930	0.923	0.923	0.923	0.923	0.923	0.878
	SS	1.000	0.999	0.997	0.996	0.995	0.993	0.991	0.980	0.970	0.959	0.949	0.949	0.949	0.949	0.949	0.887
	SV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.948	0.945	0.942	0.939	0.939	0.939	0.939	0.939	0.873

Intrastate Loc	Air Basin	PM Fuel Correction Factor pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.890	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.865
	SJV	1.000	0.863	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.836
	MD	1.000	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.882
	BA	1.000	0.778	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.747
	SD	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SV	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SCC	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
Class III Loca	SC	1.000	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.882
	SJV	1.000	0.839	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.787
	MD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NEP	1.000	0.963	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.858
	MC	1.000	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.888
	NC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.722
Industrial/Mili	SC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SJV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	MD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	BA	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	NEP	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SCC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
Passenger	SC	1.000	0.754	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.723
	SJV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.764	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.733

Appendix C
NOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	NOx Fuel Correction Factor pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SF	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SS	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Intrastate Loc	Air Basin	NOx Fuel Correction Factor pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Class III Loca	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Industrial/Mili	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Passenger	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Appendix D
SOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	SOx Fuel Correction Factor pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.896	0.793	0.689	0.586	0.482	0.379	0.327	0.276	0.225	0.173	0.173	0.173	0.173	0.173	0.011
	MC	1.000	0.977	0.955	0.932	0.909	0.887	0.864	0.755	0.645	0.535	0.426	0.426	0.426	0.426	0.426	0.042
	MD	1.000	0.979	0.957	0.936	0.914	0.893	0.871	0.817	0.763	0.709	0.654	0.654	0.654	0.654	0.654	0.067
	NEP	1.000	0.991	0.983	0.974	0.965	0.957	0.948	0.862	0.776	0.690	0.605	0.605	0.605	0.605	0.605	0.062
	SC	1.000	0.956	0.912	0.868	0.823	0.779	0.735	0.688	0.640	0.593	0.545	0.545	0.545	0.545	0.545	0.054
	SF	1.000	0.939	0.878	0.817	0.756	0.695	0.634	0.559	0.483	0.408	0.333	0.333	0.333	0.333	0.333	0.033
	SJV	1.000	0.932	0.864	0.796	0.728	0.660	0.593	0.525	0.457	0.389	0.322	0.322	0.322	0.322	0.322	0.029
	SS	1.000	0.983	0.966	0.949	0.932	0.915	0.898	0.797	0.695	0.594	0.492	0.492	0.492	0.492	0.492	0.048
	SV	1.000	0.986	0.972	0.958	0.944	0.930	0.916	0.822	0.728	0.634	0.539	0.539	0.539	0.539	0.539	0.054

Intrastate Loc	Air Basin	SOx Fuel Correction Factor pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.128	0.127	0.126	0.125	0.124	0.122	0.121	0.120	0.119	0.118	0.117	0.115	0.115	0.115	0.006
	SJV	1.000	0.139	0.136	0.133	0.130	0.126	0.123	0.120	0.116	0.113	0.110	0.106	0.103	0.103	0.103	0.006
	MD	1.000	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.006
	BA	1.000	0.173	0.164	0.154	0.144	0.134	0.124	0.114	0.104	0.095	0.085	0.075	0.065	0.065	0.065	0.006
	SD	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SV	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SCC	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
Class III Loca	SC	1.000	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.008
	SJV	1.000	0.376	0.369	0.362	0.355	0.348	0.341	0.333	0.326	0.319	0.312	0.305	0.298	0.298	0.298	0.029
	MD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NEP	1.000	0.973	0.971	0.968	0.966	0.963	0.961	0.958	0.956	0.953	0.951	0.948	0.946	0.946	0.946	0.098
	MC	1.000	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.056
	NC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
Industrial/Mili	SC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SJV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	MD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	BA	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	NEP	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SCC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
Passenger	SC	1.000	0.183	0.171	0.159	0.148	0.136	0.124	0.113	0.101	0.090	0.078	0.066	0.055	0.055	0.055	0.006
	SJV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.179	0.168	0.157	0.146	0.135	0.124	0.113	0.103	0.092	0.081	0.070	0.059	0.059	0.059	0.006

APPENDIX B

EMISSION FACTOR DERIVATION AND EMFAC-WD 2006 OUTPUT FOR HHD DIESEL-FUELED TRUCKS

Calculation of Fleet Average Emission Factors - Running Exhaust
PTS/Hadley Trucking and PMT Trucking

Model Year	Riverside County, CY 2005 Annual Average HHDD Emission Factors (g/mi)					Model Yr Distribution (vehicles)
	ROG	CO	NOx	DPM	SOx	
[redacted]	9.26	31.80	28.84	4.49	0.29	37
[redacted]	6.69	16.56	30.96	3.18	0.23	32
[redacted]	6.51	16.05	30.82	3.14	0.23	15
[redacted]	6.38	15.68	30.83	3.08	0.23	17
[redacted]	6.42	15.71	30.81	2.10	0.28	44
[redacted]	6.13	15.04	30.60	2.06	0.24	16
[redacted]	5.80	14.28	30.32	1.97	0.25	40
[redacted]	4.65	11.41	29.17	1.67	0.26	30
[redacted]	4.20	10.34	28.70	1.57	0.24	65
[redacted]	1.10	1.63	15.41	0.47	0.23	14
[redacted]	0.89	1.33	14.90	0.40	0.27	1
Fleet Avg.	***5.80***	***15.29***	***29.18***	***2.35***	***0.25***	311

Notes:
1. Assumed an average speed of 15 mph.
2. Model year distribution provided by Tom Colfield of PTS/Hadley and John O'Dwyer of PMT.
3. Emission factors calculated using EMFAC-WD 2006 with the BURDEN output option.

Calculation of Fleet Average Emission Factors - Idling Exhaust
PTS/Hadley Trucking and PMT Trucking

Model Year	Riverside County, CY 2005 Annual Average HHDD Emission Factors (g/hr)					Model Yr Distribution (vehicles)
	ROG	CO	NOx	DPM	SOx	
[redacted]	19.449	58.485	85.533	3.433	0.567	37
[redacted]	15.519	53.810	101.415	2.568	0.567	32
[redacted]	15.519	53.810	101.415	2.568	0.567	15
[redacted]	15.519	53.810	101.415	2.568	0.567	17
[redacted]	12.413	49.525	110.267	1.928	0.567	44
[redacted]	12.413	49.525	110.267	1.928	0.567	16
[redacted]	12.413	49.525	110.267	1.928	0.567	40
[redacted]	9.314	44.514	119.076	1.334	0.567	30
[redacted]	9.314	44.514	119.076	1.334	0.567	65
[redacted]	7.652	41.429	123.519	1.034	0.567	14
[redacted]	7.652	41.429	123.519	1.034	0.567	1
Fleet Avg.	***12.713***	***49.552***	***108.833***	***2.014***	***0.567***	311

Notes:
1. Model year distribution provided by Tom Colfield of PTS/Hadley and John O'Dwyer of PMT.
2. Emission factors calculated using EMFAC-WD 2006 with the EMFAC output option.

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2
Run Date : 2006/08/22 12:56:50
Scen Year: 2005 -- Model year 1990 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	970
VMT/1000	95
Trips	4910
Reactive Organic Gas Emissions	
Run Exh	0.97
Idle Exh	0.04
Start Ex	0

Total Ex	1.01
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.01
Carbon Monoxide Emissions	
Run Exh	3.33
Idle Exh	0.11
Start Ex	0

Total Ex	3.43
Oxides of Nitrogen Emissions	
Run Exh	3.02
Idle Exh	0.15
Start Ex	0

Total Ex	3.17
Carbon Dioxide Emissions (000)	
Run Exh	0.3
Idle Exh	0.01
Start Ex	0

Total Ex	0.31
PM10 Emissions	
Run Exh	0.47
Idle Exh	0.01
Start Ex	0

Total Ex	0.47
TireWear	0
BrakeWr	0

Total	0.48
Lead	0
SOx	0.03
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	28.11

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/29 12:54:47
Scen Year: 2005 -- Model year 1990 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 1990 to 1990 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	19.449	19.322

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	58.485	58.101

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	85.533	84.971

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.563

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	3.433	3.411

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+
Run Date : 2006/08/22 12:41:48
Scen Year: 2005 -- Model year 1991 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	748
VMT/1000	80
Trips	3783
Reactive Organic Gas Emissions	
Run Exh	0.59
Idle Exh	0.02
Start Ex	0

Total Ex	0.62
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.62
Carbon Monoxide Emissions	
Run Exh	1.46
Idle Exh	0.07
Start Ex	0

Total Ex	1.53
Oxides of Nitrogen Emissions	
Run Exh	2.73
Idle Exh	0.14
Start Ex	0

Total Ex	2.88
Carbon Dioxide Emissions (000)	
Run Exh	0.25
Idle Exh	0.01
Start Ex	0

Total Ex	0.26
PM10 Emissions	
Run Exh	0.28
Idle Exh	0
Start Ex	0

Total Ex	0.29
TireWear	0
BrakeWr	0

Total	0.29
Lead	0
SOx	0.02
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	23.56

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/29 12:56:21
Scen Year: 2005 -- Model year 1991 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 1991 to 1991 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	15.519	15.237

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	53.81	52.833

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	101.415	99.574

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.557

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.568	2.521

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +F
Run Date : 2006/08/22 12:58:02
Scen Year: 2005 -- Model year 1992 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	667
VMT/1000	78
Trips	3374
Reactive Organic Gas Emissions	
Run Exh	0.56
Idle Exh	0.02
Start Ex	0

Total Ex	0.58
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.58
Carbon Monoxide Emissions	
Run Exh	1.38
Idle Exh	0.07
Start Ex	0

Total Ex	1.45
Oxides of Nitrogen Emissions	
Run Exh	2.65
Idle Exh	0.13
Start Ex	0

Total Ex	2.78
Carbon Dioxide Emissions (000)	
Run Exh	0.25
Idle Exh	0.01
Start Ex	0

Total Ex	0.25
PM10 Emissions	
Run Exh	0.27
Idle Exh	0
Start Ex	0

Total Ex	0.27
TireWear	0
BrakeWr	0

Total	0.28
Lead	0
SOx	0.02
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	22.94

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/29 12:57:36
Scen Year: 2005 -- Model year 1992 selected
Season : Annual
Area : Riverside
****
Year: 2005 -- Model Years 1992 to 1992 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	15.519	15.268

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	53.81	52.939

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	101.415	99.774

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.558

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.568	2.526

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg
Run Date : 2006/08/22 13:00:03
Scen Year: 2005 -- Model year 1993 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	924
VMT/1000	118
Trips	4675
Reactive Organic Gas Emissions	
Run Exh	0.83
Idle Exh	0.03
Start Ex	0

Total Ex	0.86
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.86
Carbon Monoxide Emissions	
Run Exh	2.04
Idle Exh	0.09
Start Ex	0

Total Ex	2.13
Oxides of Nitrogen Emissions	
Run Exh	4.01
Idle Exh	0.17
Start Ex	0

Total Ex	4.18
Carbon Dioxide Emissions (000)	
Run Exh	0.38
Idle Exh	0.01
Start Ex	0

Total Ex	0.39
PM10 Emissions	
Run Exh	0.4
Idle Exh	0
Start Ex	0

Total Ex	0.4
TireWear	0
BrakeWr	0

Total	0.41
Lead	0
SOx	0.03
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	34.78

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/29 12:58:39
Scen Year: 2005 -- Model year 1993 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 1993 to 1993 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	15.519	15.389

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	53.81	53.361

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	101.415	100.568

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.562

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.568	2.546

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg
Run Date : 2006/08/22 13:03:45
Scen Year: 2005 -- Model year 1994 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1166
VMT/1000	164
Trips	5902
Reactive Organic Gas Emissions	
Run Exh	1.16
Idle Exh	0.03
Start Ex	0

Total Ex	1.18
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.18
Carbon Monoxide Emissions	
Run Exh	2.84
Idle Exh	0.11
Start Ex	0

Total Ex	2.95
Oxides of Nitrogen Emissions	
Run Exh	5.57
Idle Exh	0.24
Start Ex	0

Total Ex	5.81
Carbon Dioxide Emissions (000)	
Run Exh	0.52
Idle Exh	0.01
Start Ex	0

Total Ex	0.53
PM10 Emissions	
Run Exh	0.38
Idle Exh	0
Start Ex	0

Total Ex	0.39
TireWear	0.01
BrakeWr	0.01

Total	0.4
Lead	0
SOx	0.05
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	48.1

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Pop
Run Date : 2006/10/29 12:59:41
Scen Year: 2005 -- Model year 1994 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 1994 to 1994 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	12.413	12.326

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	49.525	49.178

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	110.267	109.494

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.563

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.928	1.914

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDI
Run Date : 2006/08/22 13:05:38
Scen Year: 2005 -- Model year 1995 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1461
VMT/1000	225
Trips	7391
Reactive Organic Gas Emissions	
Run Exh	1.52
Idle Exh	0.03
Start Ex	0

Total Ex	1.55
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.55
Carbon Monoxide Emissions	
Run Exh	3.73
Idle Exh	0.13
Start Ex	0

Total Ex	3.86
Oxides of Nitrogen Emissions	
Run Exh	7.59
Idle Exh	0.3
Start Ex	0

Total Ex	7.89
Carbon Dioxide Emissions (000)	
Run Exh	0.71
Idle Exh	0.02
Start Ex	0

Total Ex	0.73
PM10 Emissions	
Run Exh	0.51
Idle Exh	0.01
Start Ex	0

Total Ex	0.52
TireWear	0.01
BrakeWr	0.01

Total	0.53
Lead	0
SOx	0.06
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	65.97

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Pop
Run Date : 2006/10/29 13:00:50
Scen Year: 2005 -- Model year 1995 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 1995 to 1995 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	12.413	12.32

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	49.525	49.154

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	110.267	109.44

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.563

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.928	1.913

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+I
Run Date : 2006/08/22 13:07:29
Scen Year: 2005 -- Model year 1996 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1282
VMT/1000	216
Trips	6486
Reactive Organic Gas Emissions	
Run Exh	1.38
Idle Exh	0.03
Start Ex	0

Total Ex	1.41
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.41
Carbon Monoxide Emissions	
Run Exh	3.4
Idle Exh	0.12
Start Ex	0

Total Ex	3.52
Oxides of Nitrogen Emissions	
Run Exh	7.22
Idle Exh	0.26
Start Ex	0

Total Ex	7.49
Carbon Dioxide Emissions (000)	
Run Exh	0.69
Idle Exh	0.02
Start Ex	0

Total Ex	0.7
PM10 Emissions	
Run Exh	0.47
Idle Exh	0
Start Ex	0

Total Ex	0.48
TireWear	0.01
BrakeWr	0.01

Total	0.49
Lead	0
SOx	0.06
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	63.27

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Pop
Run Date : 2006/10/29 13:02:23
Scen Year: 2005 -- Model year 1996 selected
Season : Annual
Area : Riverside
****
Year: 2005 -- Model Years 1996 to 1996 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	12.413	12.342

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	49.525	49.242

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	110.267	109.637

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.564

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.928	1.917

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDI(
Run Date : 2006/08/22 13:09:15
Scen Year: 2005 -- Model year 1999 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1315
VMT/1000	283
Trips	6653
Reactive Organic Gas Emissions	
Run Exh	1.45
Idle Exh	0.02
Start Ex	0

Total Ex	1.47
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.47
Carbon Monoxide Emissions	
Run Exh	3.56
Idle Exh	0.11
Start Ex	0

Total Ex	3.67
Oxides of Nitrogen Emissions	
Run Exh	9.1
Idle Exh	0.29
Start Ex	0

Total Ex	9.39
Carbon Dioxide Emissions (000)	
Run Exh	0.9
Idle Exh	0.02
Start Ex	0

Total Ex	0.91
PM10 Emissions	
Run Exh	0.52
Idle Exh	0
Start Ex	0

Total Ex	0.52
TireWear	0.01
BrakeWr	0.01

Total	0.54
Lead	0
SOx	0.08
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	82.24

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Por
Run Date : 2006/10/29 13:03:32
Scen Year: 2005 -- Model year 1999 selected
Season : Annual
Area : Riverside
****
Year: 2005 -- Model Years 1999 to 1999 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	9.314	9.166

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	44.514	43.803

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	119.076	117.175

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.558

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.334	1.312

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg
Run Date : 2006/08/22 13:11:18
Scen Year: 2005 -- Model year 2000 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1311
VMT/1000	300
Trips	6633
Reactive Organic Gas Emissions	
Run Exh	1.39
Idle Exh	0.02
Start Ex	0

Total Ex	1.42
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.42
Carbon Monoxide Emissions	
Run Exh	3.42
Idle Exh	0.11
Start Ex	0

Total Ex	3.53
Oxides of Nitrogen Emissions	
Run Exh	9.49
Idle Exh	0.29
Start Ex	0

Total Ex	9.78
Carbon Dioxide Emissions (000)	
Run Exh	0.95
Idle Exh	0.02
Start Ex	0

Total Ex	0.97
PM10 Emissions	
Run Exh	0.52
Idle Exh	0
Start Ex	0

Total Ex	0.52
TireWear	0.01
BrakeWr	0.01

Total	0.54
Lead	0
SOx	0.08
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	87.22

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/29 13:04:47
Scen Year: 2005 -- Model year 2000 selected
Season : Annual
Area : Riverside
****
Year: 2005 -- Model Years 2000 to 2000 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	9.314	9.18

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	44.514	43.874

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	119.076	117.365

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.559

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.334	1.314

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+
Run Date : 2006/08/22 13:14:44
Scen Year: 2005 -- Model year 2004 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	628
VMT/1000	156
Trips	3179
Reactive Organic Gas Emissions	
Run Exh	0.19
Idle Exh	0.01
Start Ex	0

Total Ex	0.19
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.19
Carbon Monoxide Emissions	
Run Exh	0.28
Idle Exh	0.05
Start Ex	0

Total Ex	0.33
Oxides of Nitrogen Emissions	
Run Exh	2.65
Idle Exh	0.14
Start Ex	0

Total Ex	2.79
Carbon Dioxide Emissions (000)	
Run Exh	0.5
Idle Exh	0.01
Start Ex	0

Total Ex	0.5
PM10 Emissions	
Run Exh	0.08
Idle Exh	0
Start Ex	0

Total Ex	0.08
TireWear	0.01
BrakeWr	0

Total	0.09
Lead	0
SOx	0.04
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	45.26

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/29 13:05:55
Scen Year: 2005 -- Model year 2004 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 2004 to 2004 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	7.652	7.491

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	41.429	40.557

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	123.519	120.922

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.555

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.034	1.012

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDI
Run Date : 2006/08/22 13:16:08
Scen Year: 2005 -- Model year 2005 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	865
VMT/1000	204
Trips	4379
Reactive Organic Gas Emissions	
Run Exh	0.2
Idle Exh	0.01
Start Ex	0

Total Ex	0.21
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.21
Carbon Monoxide Emissions	
Run Exh	0.3
Idle Exh	0.07
Start Ex	0

Total Ex	0.37
Oxides of Nitrogen Emissions	
Run Exh	3.35
Idle Exh	0.2
Start Ex	0

Total Ex	3.54
Carbon Dioxide Emissions (000)	
Run Exh	0.65
Idle Exh	0.01
Start Ex	0

Total Ex	0.66
PM10 Emissions	
Run Exh	0.09
Idle Exh	0
Start Ex	0

Total Ex	0.1
TireWear	0.01
BrakeWr	0.01

Total	0.11
Lead	0
SOx	0.06
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	59.15

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Pop
Run Date : 2006/10/29 13:06:56
Scen Year: 2005 -- Model year 2005 selected
Season : Annual
Area : Riverside
****

Year: 2005 -- Model Years 2005 to 2005 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	7.652	7.564

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	41.429	40.955

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	123.519	122.106

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.567	0.561

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.034	1.022

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

APPENDIX C

EMISSION FACTOR DERIVATION AND EMFAC-WD 2006 OUTPUT FOR DIESEL-FUELED SHUTTLE VANS

Emission Factors for Diesel Fueled Shuttle Vans
Mira Loma Auto Facility

Running Exhaust Emissions

Owner	Model Yr	Emission Factors (g/mi)				
		ROG	CO	NOx	DPM	SOx
IRT	[redacted]	0.44	1.71	8.71	0.08	0.04
IRT	[redacted]	0.24	1.57	6.05	0.12	0.04
Total						

Idling Exhaust Emissions

Owner	Model Yr	Emission Factors (g/hr)				
		ROG	CO	NOx	DPM	SOx
IRT	[redacted]	3.17	26.30	75.05	0.75	0.36
IRT	[redacted]	3.17	26.30	75.05	0.75	0.35
Total						

Notes:
1. Vehicle specifications and annual VMT provided by IRT personnel
2. Running exhaust emission factors calculated from EMFAC-WD 2006 with the BURDEN output option.
3. The SOx running exhaust emission factor for the [redacted] model year vehicle provided by the EMFAC model was zero. To be conservative the emission factor for the [redacted] model year vehicle (0.04 g/mi) was also used for the [redacted] model year vehicle.
4. Idling exhaust emission factors calculated from EMFAC-WD 2006 with the EMFAC output option.

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF
Run Date : 2006/08/22 14:39:45
Scen Year: 2005 -- Model year 2000 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	LHDT1-DSL
Vehicles	35
VMT/1000	1
Trips	440
Reactive Organic Gas Emissions	
Run Exh	0
Idle Exh	0
Start Ex	0

Total Ex	0
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0
Carbon Monoxide Emissions	
Run Exh	0
Idle Exh	0
Start Ex	0

Total Ex	0
Oxides of Nitrogen Emissions	
Run Exh	0.02
Idle Exh	0
Start Ex	0

Total Ex	0.02
Carbon Dioxide Emissions (000)	
Run Exh	0
Idle Exh	0
Start Ex	0

Total Ex	0
PM10 Emissions	
Run Exh	0
Idle Exh	0
Start Ex	0

Total Ex	0
TireWear	0
BrakeWr	0

Total	0
Lead	0
SOx	0
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	0.08

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/23 13:22:16
Scen Year: 2005 -- Model year 2000 selected
Season : Annual
Area : Statewide totals
****
Year: 2005 -- Model Years 2000 to 2000 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

State Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	23.103	3.173	22.226

Pollutant Name: Carbon Monoxide   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	141.992	26.3	136.898

Pollutant Name: Oxides of Nitrogen   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	1.561	75.051	4.796

Pollutant Name: Sulfur Dioxide   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0.049	0.357	0.062

Pollutant Name: PM10   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0.753	0.033

Pollutant Name: PM10 - Tire Wear   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear   Temperature: 65F   Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF:
Run Date : 2006/08/22 14:37:59
Scen Year: 2005 -- Model year 2004 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	LHDT1-DSL
Vehicles	1397
VMT/1000	75
Trips	17573
Reactive Organic Gas Emissions	
Run Exh	0.02
Idle Exh	0
Start Ex	0

Total Ex	0.02
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.02
Carbon Monoxide Emissions	
Run Exh	0.13
Idle Exh	0
Start Ex	0

Total Ex	0.13
Oxides of Nitrogen Emissions	
Run Exh	0.5
Idle Exh	0
Start Ex	0

Total Ex	0.5
Carbon Dioxide Emissions (000)	
Run Exh	0.05
Idle Exh	0
Start Ex	0

Total Ex	0.05
PM10 Emissions	
Run Exh	0.01
Idle Exh	0
Start Ex	0

Total Ex	0.01
TireWear	0
BrakeWr	0

Total	0.01
Lead	0
SOx	0
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	4.08

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/23 13:23:54
Scen Year: 2005 -- Model year 2004 selected
Season : Annual
Area : Riverside
****
Year: 2005 -- Model Years 2004 to 2004 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Riverside

Table 1: Running Exhaust Emissions (grams/mile; gram

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	23.103	3.173	14.874

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	141.992	26.3	94.221

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	1.561	75.051	31.906

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0.049	0.351	0.174

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0.753	0.311

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

APPENDIX D

EMISSION FACTOR DERIVATION AND
OFFROAD2006 OUTPUT FOR DIESEL-FUELED FORKLIFTS

Emission Factors for Diesel Fueled Forklifts
Mira Loma Auto Facility

Owner	Make & Model	Model Yr	Fuel Type	Exhaust and Crankcase Emission Factors (g/hp-hr)					VOC Evaporative Emission Factors	
				VOC	CO	NOx	SOx	DPM	Part 1 (lb/hr)	Part 2 (lb/yr)
Progress Rail	[redacted]	[redacted]	Diesel	1.4386	3.9053	7.2237	0.7529	0.0615	-	-
Progress Rail	[redacted]	[redacted]	Diesel	1.4386	3.9053	7.2237	0.7529	0.0615	-	-
Progress Rail	[redacted]	[redacted]	Diesel	0.6614	3.4608	5.6104	0.3838	0.0615	-	-
Total										

Notes:
1. Equipment make and model from Progress Rail staff.
2. Emission factors and load factors calculated from CARB's OFFROAD2006 Model.
3. Assumes a Diesel fuel sulfur content of 130 ppm.

Cnty	SCC	HP	TechType	MYr	Population	THC-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust	PM-Exhaust	Crankcase	FuelCons.	Activity	LF	HPAvg	VOC/THC	VOC (lb/hp-hr)	CO (lb/hp-hr)	NOx (lb/hp-hr)	SOx (lb/hp-hr)	PM (lb/hp-hr)
6065	2265003040	175	G4GT25	[redacted]	0.001992554	0.000726013	0.024143519	0.000998622	0.098366879	2.02648E-05	8.69477E-06	0.000239584	10.230633	1.4206908	0.54000002	136	0.933	0.017577041	0.462805289	0.019142513	0.000388455	0.000166669
6065	2265003040	300	G4GT25	[redacted]	6.87088E-05	3.58957E-05	0.001193708	4.93741E-05	0.004863474	1.00194E-06	4.29889E-07	1.18456E-05	0.50582486	0.048989337	0.54000002	195	0.933	0.017577041	0.462805271	0.019142511	0.000388455	0.000166669
6065	2270003020	75	T1	[redacted]	14.475352	0.54595834	3.809845	5.3179626	587.32135	0.82207543	0.71836084	0.010919166	52015.824	24608.094	0.58999997	61.740002	1.053	0.001307051	0.008500426	0.011865299	0.001834193	0.001602788
6065	2270003020	100	T1	[redacted]	14.583699	0.76154578	5.3142715	7.4179144	819.24207	1.1466956	1.0020266	0.015230917	72555.773	24792.283	0.58999997	85.480003	1.053	0.001307051	0.008500426	0.011865301	0.001834193	0.001602788
6065	2270003020	100	T1	[redacted]	3.1619334	0.16386442	1.1287215	1.6001298	177.62616	0.24862401	0.19963348	0.003277289	15731.021	5375.2852	0.58999997	85.480003						
6065	2270003020	100	T2	[redacted]	12.647734	0.46085754	4.5148859	5.3397264	711.12549	0.99538499	0.42709476	0.009217151	62924.086	21501.141	0.58999997	85.480003						
6065	2270003020	100	total	[redacted]	15.8096674	0.62472196	5.6436074	6.9398562	888.75165	1.244009	0.62672824	0.01249444	78655.107	26876.4262	0.58999997	85.480003	1.053	0.000989073	0.008327195	0.010239823	0.001835547	0.000924743
6065	2270006015	75	T1	[redacted]	10.094282	0.12420369	0.57430458	1.3339913	139.48108	0.19523263	0.11621629	0.002484074	12351.536	8226.8379	0.43000001	60.759998	1.053	0.001240067	0.005343836	0.012412631	0.001816616	0.001081379
6065	2270006015	100	T1	[redacted]	13.147882	0.22328107	1.0324278	2.3981175	250.74527	0.35096994	0.20892213	0.004465622	22204.371	10715.521	0.43000001	83.860001	1.053	0.001240067	0.005343835	0.012412631	0.001816617	0.001081379
6065	2270006015	300	T1	[redacted]	0.27065411	0.007949804	0.019512761	0.14271273	13.483438	0.018873278	0.006360457	0.000158996	1192.8628	220.58307	0.43000001	243.3						
6065	2270006015	300	T2	[redacted]	1.0826164	0.031785008	0.078051046	0.40783694	53.933804	0.075493187	0.015394036	0.0006357	4771.4512	882.33228	0.43000001	243.3						
6065	2270006015	300	total	[redacted]	1.35327051	0.039734812	0.097563807	0.55054967	67.417242	0.094366465	0.021754493	0.000794696	5964.314	1102.91535	0.43000001	243.3	1.053	0.000739006	0.001691087	0.009542754	0.001635667	0.000377074

APPENDIX E

EMISSION FACTOR DERIVATION, EMFAC-WD 2006 OUTPUT, SPECIATE DATABASE SECTIONS FOR NEW VEHICLES

Emission Factors for New Vehicles
Mira Loma Auto Facility

Activity Assumptions (per Vehicle)	
Miles driven	[redacted]
Vehicle trips	1
# days in yard	1

2005 MY Vehicle Class Population Distribution (<8500 LBS GVWR)				
	PC	LDT1	LDT2	MDV
Population counts	[redacted]	[redacted]	[redacted]	[redacted]
Fraction of LD/MD total	0.4970	0.0898	0.2484	0.1648

Per Vehicle Emission Rates by Process						
Emission Category	Units	PC	LDT1	LDT2	MDV	AVERAGE
ROG Exhaust	g/mi	0.024	0.016	0.024	0.039	0.026
ROG Running Loss	g/mi	0.009	0.000	0.000	0.000	0.005
ROG Start	g/trip	0.056	0.000	0.056	0.084	0.056
ROG Hot Soak	g/trip	0.000	0.000	0.000	0.000	0.000
ROG Resting Loss	g/day	0.000	0.000	0.000	0.000	0.000
ROG Diurnal	g/day	0.000	0.000	0.000	0.000	0.000
CO Exhaust	g/mi	0.959	0.957	0.950	1.128	0.985
CO Start	g/trip	0.952	0.929	0.896	1.182	0.974
NOX Exhaust	g/mi	0.067	0.066	0.090	0.154	0.087
NOX Start	g/trip	0.056	0.000	0.056	0.169	0.070
PM10 Exhaust	g/mi	0.006	0.000	0.012	0.010	0.008
PM10 Tire	g/mi	0.009	0.000	0.006	0.010	0.008
PM10 Brake	g/mi	0.012	0.016	0.012	0.010	0.012
PM10 Start	g/trip	0.000	0.000	0.000	0.000	0.000
SOX	g/mi	0.006	0.000	0.006	0.010	0.006

Pollutant	Per Vehicle Emissions (Grams)
Total ROG	0.071
Total CO	1.466
Total NOX	0.113
Total PM10	0.014
Total SOX	0.003

Notes:
1. Emission factors calculated using EMFAC-WD 2006.

Title : Riverside County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Pop
Run Date : 2006/08/25 15:10:21
Scen Year: 2005 -- Model year 2005 selected
Season : Annual
Area : Riverside County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 61 Riverside (SC)
Emissions: Tons Per Day
****

	LDA-TOT	LDT1-TOT	LDT2-TOT	MDV-TOT
Vehicles	49412	8931	24696	16382
VMT/1000	2969	550	1519	941
Trips	324110	58582	161990	107455
Reactive Organic Gas Emissions				
Run Exh	0.08	0.01	0.04	0.04
Idle Exh	0	0	0	0
Start Ex	0.02	0	0.01	0.01
	-------	-------	-------	-------
Total Ex	0.1	0.02	0.05	0.05
Diurnal	0	0	0	0
Hot Soak	0	0	0	0
Running	0.03	0	0	0
Resting	0	0	0	0
	-------	-------	-------	-------
Total	0.13	0.02	0.06	0.06
Carbon Monoxide Emissions				
Run Exh	3.14	0.58	1.59	1.17
Idle Exh	0	0	0	0
Start Ex	0.34	0.06	0.16	0.14
	-------	-------	-------	-------
Total Ex	3.48	0.64	1.76	1.31
Oxides of Nitrogen Emissions				
Run Exh	0.22	0.04	0.15	0.16
Idle Exh	0	0	0	0
Start Ex	0.02	0	0.01	0.02
	-------	-------	-------	-------
Total Ex	0.24	0.04	0.16	0.18
Carbon Dioxide Emissions (000)				
Run Exh	2.19	0.51	1.41	1.19
Idle Exh	0	0	0	0
Start Ex	0.03	0.01	0.02	0.01
	-------	-------	-------	-------
Total Ex	2.21	0.52	1.43	1.2
PM10 Emissions				
Run Exh	0.02	0	0.02	0.01
Idle Exh	0	0	0	0
Start Ex	0	0	0	0
	-------	-------	-------	-------
Total Ex	0.02	0	0.02	0.01
TireWear	0.03	0	0.01	0.01
BrakeWr	0.04	0.01	0.02	0.01
	-------	-------	-------	-------
Total	0.09	0.02	0.05	0.03
Lead	0	0	0	0
SOx	0.02	0	0.01	0.01
Fuel Consumption (000 gallons)				
Gasoline	227.09	52.94	146.22	123.29
Diesel	0	0	0	0

ORGPROF	SAROAD	ORGFRAC	ORGPROFN	CAS	CHEM_NAME
2105	43502	0.01579326	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	50000	formaldehyde
2105	43301	0.00122213	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	67561	methyl alcohol
2105	45201	0.02472139	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	71432	benzene
2105	43203	0.06360455	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	74851	ethylene
2105	43503	0.00279142	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	75070	acetaldehyde
2105	43243	0.00141678	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	78795	isoprene
2105	43552	0.00018262	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	78933	methyl ethyl ketone (mek) (2-butanone)
2105	98046	0.0004716	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	91203	naphthalene
2105	45204	0.01237974	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	95476	o-xylene
2105	45208	0.0096385	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	95636	1,2,4-trimethylbenzene
2105	98043	0.00009633	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	98828	isopropylbenzene (cumene)
2105	45203	0.01048738	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	100414	ethylbenzene
2105	45220	0.00122814	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	100425	styrene
2105	43218	0.00545239	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	106990	1,3-butadiene
2105	43505	0.00132446	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	107028	acrolein (2-propenal)
2105	45205	0.03562617	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	108383	m-xylene
2105	45202	0.05755816	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	108883	toluene
2105	43231	0.01598992	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	110543	n-hexane
2105	43248	0.00614272	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	110827	cyclohexane
2105	43205	0.03062128	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	115071	propylene
2105	43276	0.02308187	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	540841	2,2,4-trimethylpentane
2105	98156	0.00028898	Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)	4170303	crotonaldehyde

APPENDIX F

EMISSION FACTOR DERIVATION AND OFFROAD2006 OUTPUT FOR DIESEL-FUELED AIR COMPRESSOR

Emission Factors for Diesel-Fueled Air Compressor
Mira Loma Auto Facility

Owner	Equipment	Make	Engine Make	Model Year	Fuel Type	Exhaust and Crankcase Emission Factors (g/hp-hr)					VOC Evaporative Emission Factors	
						VOC	CO	NOx	DPM	SOx	Part 1 (g/hr)	Part 2 (g/yr)
Progress Rail	Portable Air Compressor	[redacted]	[redacted]	[redacted]	Diesel	0.202	0.957	4.179	0.048	0.100	-	-
Total												

Notes:
1. Emission factors and load factors from CARB's OFFROAD Model.
2. Assumes a Diesel fuel sulfur content of 130 ppm.

Cnty	SCC	HP	TechType	MYr	Population	THC-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust	PM-Exhaust	Crankcase	FuelCons.	Activity	LF	HPAvg	VOC/THC	VOC (lb/hp-hr)	CO (lb/hp-hr)	NOx (lb/hp-hr)	SOx (lb/hp-hr)	PM (lb/hp-hr)
6065	2265003040	175	G4GT25	[redacted]	0.001992554	0.000726013	0.024143519	0.000998622	0.098366879	2.02648E-05	8.69477E-06	0.000239584	10.230633	1.4206908	0.54000002	136	0.933	0.017577041	0.462805289	0.019142513	0.000388455	0.000166669
6065	2265003040	300	G4GT25		6.87088E-05	3.58957E-05	0.001193708	4.93741E-05	0.004863474	1.00194E-06	4.29889E-07	1.18456E-05	0.50582486	0.048989337	0.54000002	195	0.933	0.017577041	0.462805271	0.019142511	0.000388455	0.000166669
6065	2270003020	75	T1		14.475352	0.54595834	3.809845	5.3179626	587.32135	0.82207543	0.71836084	0.010919166	52015.824	24608.094	0.58999997	61.740002	1.053	0.001307051	0.008500426	0.011865299	0.001834193	0.001602788
6065	2270003020	100	T1		14.583699	0.76154578	5.3142715	7.4179144	819.24207	1.1466956	1.0020266	0.015230917	72555.773	24792.283	0.58999997	85.480003	1.053	0.001307051	0.008500426	0.011865301	0.001834193	0.001602788
6065	2270003020	100	T1		3.1619334	0.16386442	1.1287215	1.6001298	177.62616	0.24862401	0.19963348	0.003277289	15731.021	5375.2852	0.58999997	85.480003						
6065	2270003020	100	T2		12.647734	0.46085754	4.5148859	5.3397264	711.12549	0.99538499	0.42709476	0.009217151	62924.086	21501.141	0.58999997	85.480003						
6065	2270003020	100	total		15.8096674	0.62472196	5.6436074	6.9398562	888.75165	1.244009	0.62672824	0.01249444	78655.107	26876.4262	0.58999997	85.480003	1.053	0.000989073	0.008327195	0.010239823	0.001835547	0.000924743
6065	2270006015	75	T1		10.094282	0.12420369	0.57430458	1.3339913	139.48108	0.19523263	0.11621629	0.002484074	12351.536	8226.8379	0.43000001	60.759998	1.053	0.001240067	0.005343836	0.012412631	0.001816616	0.001081379
6065	2270006015	100	T1		13.147882	0.22328107	1.0324278	2.3981175	250.74527	0.35096994	0.20892213	0.004465622	22204.371	10715.521	0.43000001	83.860001	1.053	0.001240067	0.005343835	0.012412631	0.001816617	0.001081379
6065	2270006015	300	T1		0.27065411	0.007949804	0.019512761	0.14271273	13.483438	0.018873278	0.006360457	0.000158996	1192.8628	220.58307	0.43000001	243.3						
6065	2270006015	300	T2		1.0826164	0.031785008	0.078051046	0.40783694	53.933804	0.075493187	0.015394036	0.0006357	4771.4512	882.33228	0.43000001	243.3						
6065	2270006015	300	total		1.35327051	0.039734812	0.097563807	0.55054967	67.417242	0.094366465	0.021754493	0.000794696	5964.314	1102.91535	0.43000001	243.3	1.053	0.000739006	0.001691087	0.009542754	0.001635667	0.000377074

APPENDIX G

EMISSION FACTOR DERIVATION, OFFROAD2006 OUTPUT, AND SPECIATE DATABASE SECTIONS FOR RAMPS

Criteria Pollutant Emission Factors for Auto Loading/Unloading Ramps
Mira Loma Auto Facility

					Exhaust and Crankcase Emission Factors (g/hp-hr)					VOC Evaporative Emission Factors	
Owner	Make	Engine	Engine MY	Fuel Type	VOC	CO	NOx	PM10	SOx	Part 1 (g/hr)	Part 2 (g/yr)
UP	[redacted]	[redacted]	[redacted]	Gasoline	4.06	53.48	11.79	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	4.06	53.48	11.79	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	4.06	53.48	11.79	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	4.06	53.48	11.79	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	3.96	52.52	11.77	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	3.96	52.52	11.77	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	3.96	52.52	11.77	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	3.96	52.52	11.77	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	3.96	52.52	11.77	0.06	0.01	0.02	0.03
UP	[redacted]	[redacted]	[redacted]	Gasoline	3.96	52.52	11.77	0.06	0.01	0.02	0.03

Notes:
1. The engine model year for the [redacted] ramps is unknown. It was assumed that they were the same vintage as the [redacted] ramps.
2. Emission factors and load factors from OFFROAD 2006 model.
3. Assumes a gasoline sulfur conent of 15 ppm.

Cnty	SCC	HP	TechType	MYr	Population	THC-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust	PM-Exhaust	Crankcase	FuelCons.	Activity	LF	HPAvg	VOC/THC	VOC (lb/hp-hr)	CO (lb/hp-hr)	NOx (lb/hp-hr)	SOx (lb/hp-hr)	PM (lb/hp-hr)
6065	2265003040	175	G4GT25	[redacted]	0.001992554	0.000726013	0.024143519	0.000998622	0.098366879	2.02648E-05	8.69477E-06	0.000239584	10.230633	1.4206908	0.54000002	136	0.933	0.017577041	0.462805289	0.019142513	0.000388455	0.000166669
6065	2265003040	300	G4GT25	[redacted]	6.87088E-05	3.58957E-05	0.001193708	4.93741E-05	0.004863474	1.00194E-06	4.29889E-07	1.18456E-05	0.50582486	0.048989337	0.54000002	195	0.933	0.017577041	0.462805271	0.019142511	0.000388455	0.000166669
6065	2270003020	75	T1	[redacted]	14.475352	0.54595834	3.609845	5.3179626	587.32135	0.82207543	0.71836084	0.010919166	52015.824	24608.094	0.58999997	61.740002	1.053	0.001307051	0.008500426	0.011865299	0.001834193	0.001602788
6065	2270003020	100	T1	[redacted]	14.583699	0.76154578	5.3142715	7.4179144	819.24207	1.1466956	1.0020266	0.015230917	72555.773	24792.283	0.58999997	85.480003	1.053	0.001307051	0.008500426	0.011865301	0.001834193	0.001602788
6065	2270003020	100	T1	[redacted]	3.1619334	0.16386442	1.1287215	1.6001298	177.62616	0.24862401	0.19963348	0.003277289	15731.021	5375.2852	0.58999997	85.480003						
6065	2270003020	100	T2	[redacted]	12.647734	0.46085754	4.5148859	5.3397264	711.12549	0.99538499	0.42709476	0.009217151	62924.086	21501.141	0.58999997	85.480003						
6065	2270003020	100	total	[redacted]	15.8096674	0.62472196	5.6436074	6.9398562	888.75165	1.244009	0.62672824	0.01249444	78655.107	26876.4262	0.58999997	85.480003	1.053	0.000989073	0.008327195	0.010239823	0.001835547	0.000924743
6065	2270006015	75	T1	[redacted]	10.094282	0.12420369	0.57430458	1.3339913	139.48108	0.19523263	0.11621629	0.002484074	12351.536	8226.8379	0.43000001	60.759998	1.053	0.001240067	0.005343836	0.012412631	0.001816616	0.001081379
6065	2270006015	100	T1	[redacted]	13.147882	0.22328107	1.0324278	2.3981175	250.74527	0.35096994	0.20892213	0.004465622	22204.371	10715.521	0.43000001	83.860001	1.053	0.001240067	0.005343835	0.012412631	0.001816617	0.001081379
6065	2270006015	300	T1	[redacted]	0.27065411	0.007949804	0.019512761	0.14271273	13.483438	0.018873278	0.006360457	0.000158996	1192.8628	220.58307	0.43000001	243.3						
6065	2270006015	300	T2	[redacted]	1.0826164	0.031785008	0.078051046	0.40783694	53.933804	0.075493187	0.015394036	0.0006357	4771.4512	882.33228	0.43000001	243.3						
6065	2270006015	300	total	[redacted]	1.35327051	0.039734812	0.097563807	0.55054967	67.417242	0.094366465	0.021754493	0.000794696	5964.314	1102.91535	0.43000001	243.3	1.053	0.000739006	0.001691087	0.009542754	0.001635667	0.000377074

Cnty	SCC	HP	TechType	MYr	Population	Hot-Soaks	Diurnal	Displacement	Spillage	RunLoss	TankPerm	HosePerm	uelCons.	Activity	HS+Run+Sp+Dis (lb/hr)	Di+Perm (lb/yr)
6065	2265003040	175	E00000000	[redacted]	0.001992554	1.69916E-06	5.2937E-05	3.79935E-05	5.85329E-07	3.77416E-06	0	0	10.23063	1.420691	0.062015129	53.13485676
6065	2265003040	300	E00000000	[redacted]	6.87088E-05	5.85916E-08	2.61732E-06	1.87848E-06	2.01838E-08	1.30144E-07	0	0	0.505825	0.048989	0.085218596	76.18601291

ORGPROF	SAROAD	ORGFRAC	ORGPROFN	CAS	CHEM_NAME
665	43502	0.03004998	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	50000	formaldehyde
665	43301	0.00351	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	67561	methyl alcohol
665	45201	0.03384	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	71432	benzene
665	43203	0.0916	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	74851	ethylene
665	43503	0.00976	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	75070	acetaldehyde
665	43243	0.00143	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	78795	isoprene
665	43552	0.00061	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	78933	methyl ethyl ketone (mek) (2-butanone)
665	98046	0.00133	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	91203	naphthalene
665	45204	0.01587998	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	95476	o-xylene
665	45208	0.01290998	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	95636	1,2,4-trimethylbenzene
665	98043	0.00051	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	98828	isopropylbenzene (cumene)
665	45203	0.01537	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	100414	ethylbenzene
665	45220	0.00133	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	100425	styrene
665	43218	0.00833	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	106990	1,3-butadiene
665	43505	0.00184	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	107028	acrolein (2-propenal)
665	45205	0.04559999	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	108383	m-xylene
665	45202	0.06957	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	108883	toluene
665	43231	0.01341998	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	110543	n-hexane
665	43248	0.00461	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	110827	cyclohexane
665	43273	0.00072	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	110838	cyclohexene
665	43205	0.05021	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	115071	propylene
665	43504	0.00133	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	123386	propionaldehyde
665	43276	0.02039	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	540841	2,2,4-trimethylpentane
665	98156	0.00133	Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)	4170303	crotonaldehyde

APPENDIX H

DETAILED EMISSION CALCULATIONS

Summary of Diesel Particulate Matter Emissions
Mira Loma Auto Facility

Source	DPM Emissions (tpy)
Locomotives	4.426
HHD Diesel Trucks	0.204
Fork Lifts	0.230
Shuttle Vans	0.004
Air Compressors	0.005
Total	**4.867**

Summary of Toxic Air Contaminant Emissions
Mira Loma Auto Facility

CAS	Chemical Name	Emissions (tpy)		
		New Vehicles	Ramps	Total
95636	1,2,4-trimethylbenzene	5.29E-04	1.55E-01	1.55E-01
106990	1,3-butadiene	2.99E-04	1.00E-01	1.00E-01
540841	2,2,4-trimethylpentane	1.27E-03	2.45E-01	2.46E-01
75070	acetaldehyde	1.53E-04	1.17E-01	1.17E-01
107028	acrolein (2-propenal)	7.27E-05	2.21E-02	2.22E-02
71432	benzene	1.36E-03	4.06E-01	4.08E-01
4170303	crotonaldehyde	1.59E-05	1.60E-02	1.60E-02
110827	cyclohexane	6.14E-03	5.53E-02	6.15E-02
110838	cyclohexene	-	8.64E-03	8.64E-03
100414	ethylbenzene	1.05E-02	1.85E-01	1.95E-01
74851	ethylene	6.36E-02	1.10E+00	1.16E+00
50000	formaldehyde	1.58E-02	3.61E-01	3.77E-01
78795	isoprene	1.42E-03	1.72E-02	1.86E-02
98828	isopropylbenzene (cumene)	5.29E-06	6.12E-03	6.13E-03
67561	methyl alcohol	6.71E-05	4.21E-02	4.22E-02
78933	methyl ethyl ketone (mek) (2-butanone)	1.00E-05	7.32E-03	7.33E-03
108383	m-xylene	1.96E-03	5.47E-01	5.49E-01
91203	naphthalene	2.59E-05	1.60E-02	1.60E-02
110543	n-hexane	8.78E-04	1.61E-01	1.62E-01
95476	o-xylene	6.79E-04	1.91E-01	1.91E-01
123386	propionaldehyde	-	1.60E-02	1.60E-02
115071	propylene	1.68E-03	6.03E-01	6.04E-01
100425	styrene	6.74E-05	1.60E-02	1.60E-02
108883	toluene	3.16E-03	8.35E-01	8.38E-01
Total		**1.10E-01**	**5.23E+00**	**5.34E+00**

Summary of Emissions from Locomotives
Mira Loma Auto Facility, Los Angeles, CA

Activity	DPM Emissions (tpy)
Through trains	0.017
Auto trains	1.268
Other trains	0.529
Power moves	0.231
Yard operations	2.380
Total	**4.426**

Emissions from Heavy-Heavy Duty Diesel-Fueled Auto Carrier Trucks
Mira Loma Auto Facility

Running Exhaust Emissions

Number of Vehicles Hauled	Vehicles per Truck	Number of Truck Trips	VMT per Trip	VMT per Year	Emission Factors (g/mi)					Emissions (tpy)				
					ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5.80	15.29	29.18	2.35	0.25	0.45	1.18	2.26	0.182	0.02

Idling Exhaust Emissions

Number of Truck Trips	Idling		Emission Factors (g/hr)					Emissions (tpy)				
	(mins/trip)	(hr/yr)	ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
[redacted]	[redacted]	[redacted]	12.71	49.55	108.83	2.01	0.57	0.137	0.533	1.170	0.022	0.006

Notes:
1. Number of vehicles hauled provided by Union Pacific.
2. Number of vehicles per truck is the average from the September 2005 gate release log.
3. VMT per trip estimated based on personal observation.
4. Running exhaust emission factors are from EMFAC-WD 2006 using the BURDEN output option. A fleet weighted average, based on the model year distribution of PMT and Hadley trucks, at average speed of 15 mph was used.
5. Idling exhaust emission factors from EMFAC 2007 using the EMFAC output option.

Summary of Emissions from Diesel Fueled Forklifts
Mira Loma Auto Facility

Owner	Make & Model	Model Yr	Fuel Type	Rated Capacity (hp)	No. of Units	Load Factor	Hours of Operation (hr/yr)	Exhaust and Crankcase Emission Factors (g/hp-hr)					VOC Evaporative Emission Factors		Emissions (tpy)				
								VOC	CO	NOx	DPM	SOx	Part 1 (lb/hr)	Part 2 (lb/yr)	VOC	CO	NOx	DPM	SOx
Progress Rail	[redacted]	[redacted]	Diesel	62	1	0.30	1,460	1.44	3.91	7.22	0.75	0.06	-	-	0.043	0.117	0.216	0.023	0.002
Progress Rail	[redacted]	[redacted]	Diesel	84	1	0.30	6,570	1.44	3.91	7.22	0.75	0.06	-	-	0.263	0.713	1.318	0.137	0.011
Progress Rail	[redacted]	[redacted]	Diesel	84	1	0.30	6,570	0.66	3.46	5.61	0.38	0.06	-	-	0.121	0.632	1.024	0.070	0.011
Total															**0.426**	**1.461**	**2.559**	**0.230**	**0.024**

Notes:
1. Equipment make and model from Progress Rail staff.
2. Per Jesse Collett of Progress Rail, [redacted] is operated approximately 4 hour/day and the [redacted] operate 16 to 18 hours per day, each. To be conservative, 18 hours/day of operation was used for the [redacted]
3. Emission factors and load factors calculated from CARB's OFFROAD2006 Model.
4. Assumes a Diesel fuel sulfur content of 130 ppm.

Summary of Emissions from Diesel Fueled Shuttle Vans
Mira Loma Auto Facility

Running Exhaust Emissions

		Annual VMT	Emission Factors (g/mi)					Emissions (tpy)				
Owner	Model Yr	(mi/yr)	ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
IRT	[redacted]	15,000	0.44	1.71	8.71	0.08	0.04	0.007	0.028	0.144	0.001	0.001
IRT	[redacted]	15,000	0.24	1.57	6.05	0.12	0.04	0.004	0.026	0.100	0.002	0.001
Total								**0.011**	**0.054**	**0.244**	**0.003**	**0.001**

Idling Exhaust Emissions

	Idling		Emission Factors (g/hr)					Emissions (tpy)				
Model Yr	(min/day)	(hr/yr)	ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
[redacted]	30	183	3.17	26.30	75.05	0.75	0.36	0.001	0.005	0.015	0.0002	0.000
[redacted]	30	183	3.17	26.30	75.05	0.75	0.35	0.001	0.005	0.015	0.0002	0.000
Total								**0.001**	**0.011**	**0.030**	**0.0003**	**0.000**

Notes:
1. Vehicle specifications and annual VMT provided by IRT personnel
2. Idling time (min/day) is an engineering estimate.
3. Running exhaust emission factors calculated from EMFAC-WD 2006 with the BURDEN output option.
4. The SOx running exhaust emission factor for the [redacted] model year vehicle provided by the EMFAC model was zero. To be conservative the emission factor for the [redacted] model year vehicle (0.04 g/mi) was also used for the [redacted] model year vehicle.
5. Idling exhaust emission factors calculated from EMFAC-WD 2006 with the EMFAC output option.

Summary of Emissions from New Vehicles
Mira Loma Auto Facility

Number of Vehicles	Emission Factors (g/vehicle)					Annual Emissions (tpy)				
	ROG	CO	NOx	PM10	SOx	ROG	CO	NOx	PM10	SOx
[redacted]	0.071	1.466	0.113	0.014	0.003	0.055	1.135	0.088	0.011	0.002

Notes:
1. Number of vehicles arriving at the yard provided by Union Pacific.
2. Emission factors calculated using the EMFAC-WD 2006 model. It was assumed that all vehicles are model year 2005 gasoline-fueled passenger cars, light duty trucks, and medium-duty vehicles. It was assumed that each vehicle made one trip of [redacted] miles in length at an average vehicle speed of 15 mph and that each vehicle remained in the Yard for 1 day.

Toxic Air Contaminant Emissions from New Vehicles
Mira Loma Auto Facility

CAS	Chemical Name	Organic Fraction	Emissions (tpy)
95636	1,2,4-trimethylbenzene	0.0096	5.29E-04
106990	1,3-butadiene	0.0055	2.99E-04
540841	2,2,4-trimethylpentane	0.0231	1.27E-03
75070	acetaldehyde	0.0028	1.53E-04
107028	acrolein (2-propenal)	0.0013	7.27E-05
71432	benzene	0.0247	1.36E-03
4170303	crotonaldehyde	0.0003	1.59E-05
110827	cyclohexane	0.0061	3.37E-04
100414	ethylbenzene	0.0105	5.76E-04
74851	ethylene	0.0636	3.49E-03
50000	formaldehyde	0.0158	8.67E-04
78795	isoprene	0.0014	7.78E-05
98828	isopropylbenzene (cumene)	0.0001	5.29E-06
67561	methyl alcohol	0.0012	6.71E-05
78933	methyl ethyl ketone (mek) (2-butanone)	0.0002	1.00E-05
108383	m-xylene	0.0356	1.96E-03
91203	naphthalene	0.0005	2.59E-05
110543	n-hexane	0.0160	8.78E-04
95476	o-xylene	0.0124	6.79E-04
115071	propylene	0.0306	1.68E-03
100425	styrene	0.0012	6.74E-05
108883	toluene	0.0576	3.16E-03
Total		**0.32**	**0.018**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from profile 2105 "Cat stabilzed exhaust 2005 SSD etoh 2% O (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.

Summary of Criteria Pollutant Emissions from Auto Loading/Unloading Ramps
Mira Loma Auto Facility

Owner	Make	Engine	Engine MY	Fuel Type	Rating (hp)	No. of Units	Load Factor	Operating Schedule (hr/day)	Operating Schedule (hrs/yr)	Exhaust and Crankcase Emission Factors (g/hp-hr) VOC	CO	NOx	PM10	SOx	VOC Evaporative Emission Factors Part 1 (g/hr)	Part 2 (g/yr)	Emissions (tpy) ROG	CO	NOx	PM10	SOx
UP	[redacted]	[redacted]	[redacted]	Gasoline	300	1	0.53	6	2,190	4.058	53.477	11.788	0.060	0.007	8.50	13.47	1.58	20.53	4.52	0.02	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	300	1	0.53	6	2,190	4.058	53.477	11.788	0.060	0.007	8.50	13.47	1.58	20.53	4.52	0.02	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	300	1	0.53	6	2,190	4.058	53.477	11.788	0.060	0.007	8.50	13.47	1.58	20.53	4.52	0.02	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	300	1	0.53	6	2,190	4.058	53.477	11.788	0.060	0.007	8.50	13.47	1.58	20.53	4.52	0.02	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	300	1	0.53	6	2,190	3.957	52.515	11.765	0.060	0.007	8.50	13.47	1.54	20.16	4.52	0.02	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	300	1	0.53	6	2,190	3.957	52.515	11.765	0.060	0.007	8.50	13.47	1.54	20.16	4.52	0.02	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	125	1	0.53	6	2,190	3.957	52.515	11.765	0.060	0.007	8.50	13.47	0.65	8.40	1.88	0.01	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	125	1	0.53	6	2,190	3.957	52.515	11.765	0.060	0.007	8.50	13.47	0.65	8.40	1.88	0.01	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	125	1	0.53	6	2,190	3.957	52.515	11.765	0.060	0.007	8.50	13.47	0.65	8.40	1.88	0.01	0.00
UP	[redacted]	[redacted]	[redacted]	Gasoline	125	1	0.53	6	2,190	3.957	52.515	11.765	0.060	0.007	8.50	13.47	0.65	8.40	1.88	0.01	0.00
Total - 300 hp units																	**9.39**	**122.42**	**27.13**	**0.14**	**0.02**
Total - 125 hp units																	**2.61**	**33.60**	**7.53**	**0.04**	**0.00**
Total - all units																	**12.00**	**156.02**	**34.66**	**0.18**	**0.02**

Notes:
1. Operating schedule assumes that the ramps operate for 15 minutes per hour, per operators.
2. The engine model year for the [redacted] ramps is unknown. It was assumed that they were the same vintage as the [redacted] ramps.
3. Emission factors and load factors from OFFROAD 2006 model.
4. Assumes a gasoline sulfur conent of 15 ppm.

Summary of Toxic Air Contaminant Emissions from Auto Loading/Unloading Ramps
Mira Loma Auto Facility

CAS	Chemical Name	Organic Fraction	Emissions (tpy)
95636	1,2,4-trimethylbenzene	0.0129	0.155
106990	1,3-butadiene	0.0083	0.100
540841	2,2,4-trimethylpentane	0.0204	0.245
75070	acetaldehyde	0.0098	0.117
107028	acrolein (2-propenal)	0.0018	0.022
71432	benzene	0.0338	0.406
4170303	crotonaldehyde	0.0013	0.016
110827	cyclohexane	0.0046	0.055
110838	cyclohexene	0.0007	0.009
100414	ethylbenzene	0.0154	0.185
74851	ethylene	0.0916	1.100
50000	formaldehyde	0.0300	0.361
78795	isoprene	0.0014	0.017
98828	isopropylbenzene (cumene)	0.0005	0.006
67561	methyl alcohol	0.0035	0.042
78933	methyl ethyl ketone (mek)	0.0006	0.007
108383	m-xylene	0.0456	0.547
91203	naphthalene	0.0013	0.016
110543	n-hexane	0.0134	0.161
95476	o-xylene	0.0159	0.191
123386	propionaldehyde	0.0013	0.016
115071	propylene	0.0502	0.603
100425	styrene	0.0013	0.016
108883	toluene	0.0696	0.835
Total		**0.44**	**5.23**

Notes:
1. Organic fraction from ARB's SPECIATE database. Data from profile 665 "Non-cat stabilized exhaust 1996 SSD 2.0% o etoh (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.

Summary of Emissions from Diesel-Fueled Air Compressor
Mira Loma Auto Facility

											Exhaust and Crankcase Emission Factors (g/hp-hr)					VOC Evaporative Emission Factors		Emissions (tpy)				
			Engine	Model	Fuel	Rating	No. of	Load	Operating Schedule													
Owner	Equipment	Make	Make	Year	Type	(hp)	Units	Factor	(hr/day)	(hr/yr)	VOC	CO	NOx	DPM	SOx	Part 1 (g/hr)	Part 2 (g/yr)	VOC	CO	NOx	DPM	SOx
Progress Rail	Portable Air Compressor	[redacted]	[redacted]	[redacted]	Diesel	125	1	0.48	4	1,460	0.202	0.957	4.179	0.048	0.100	-	-	0.020	0.092	0.404	0.005	0.010
Total																		**0.020**	**0.092**	**0.404**	**0.005**	**0.010**

Notes:
1. Emission factors and load factors from CARB's OFFROAD Model.
2. Assumes a Diesel fuel sulfur content of 130 ppm.

APPENDIX I

DETAILED RISK SCREENING CALCULATIONS

Summary of Risk Index Values
Mira Loma Auto Facility, Los Angeles, CA

Source	Risk Index Value Cancer	% of Total Cancer Risk	Risk Index Value Chronic	% of Total Chronic Risk
Locomotives	1.33E-03	88.97	2.21E+01	0.59
HHD Diesel Trucks	6.11E-05	4.09	1.02E+00	0.03
Fork Lifts	6.90E-05	4.62	1.15E+00	0.03
Shuttle Vans	1.09E-06	0.07	1.81E-02	0.00
Air Compressor	1.38E-06	0.09	2.31E-02	0.00
Ramps	3.18E-05	2.13	3.74E+03	99.35
New Vehicles	1.86E-07	0.01	1.57E-09	0.00
Total	**1.49E-03**	**100.00**	**3.76E+03**	**100.00**
De Minimis Sources (% of Total)		2.31		0.00

Calculation of Risk Index Values for Diesel-Fueled Sources
Mira Loma Auto Facility

Source	DPM Emissions (tpy)	Unit Risk Factor Cancer	Cancer Risk Index Value	Unit Risk Factor Chronic	Chronic Risk Index Value
Locomotives	4.426	3.00E-04	1.33E-03	5.00E+00	2.21E+01
HHD Diesel Trucks	0.204	3.00E-04	6.11E-05	5.00E+00	1.02E+00
Fork Lifts	0.230	3.00E-04	6.90E-05	5.00E+00	1.15E+00
Shuttle Vans	0.004	3.00E-04	1.09E-06	5.00E+00	1.81E-02
Air Compressor	0.005	3.00E-04	1.38E-06	5.00E+00	2.31E-02
Total	**4.867**		**1.46E-03**		**2.43E+01**

Notes:
1. Unit risk factor from Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, April 25, 2005. Cancer inhalation risk used.

Calculation of Risk Index Values for New Vehicles and Ramps
Mira Loma Auto Facility

CAS	Chemical Name	Emissions (tpy)		Unit Risk Factor	Unit Risk Factor	Cancer Risk Index Value		Chronic Risk Index Value	
		New Vehicles	Ramps	Cancer	Chronic	New Vehicles	Ramps	New Vehicles	Ramps
95636	1,2,4-trimethylbenzene	0.0005	0.1550			0	NA	0	NA
106990	1,3-butadiene	0.0003	0.1000	1.70E-04	2.00E+01	5.09E-08	1.70E-05	1.52E-11	2.00E+00
540841	2,2,4-trimethylpentane	0.0013	0.2448			0.00E+00	0.00E+00	0.00E+00	0.00E+00
75070	acetaldehyde	0.0002	0.1172	2.70E-06	9.00E+00	4.14E-10	3.16E-07	6.34E-14	1.05E+00
107028	acrolein (2-propenal)	0.0001	0.0221		6.00E-02	0.00E+00	0.00E+00	0.00E+00	1.33E-03
71432	benzene	0.0014	0.4062	2.90E-05	6.00E+01	3.93E-08	1.18E-05	5.34E-11	2.44E+01
4170303	crotonaldehyde	0.0000	0.0160			0.00E+00	0.00E+00	0.00E+00	0.00E+00
110827	cyclohexane	0.0061	0.0553			0.00E+00	0.00E+00	0.00E+00	0.00E+00
110838	cyclohexene	-	0.0086						
100414	ethylbenzene	0.0105	0.1845		2.00E+03	0.00E+00	0.00E+00	0.00E+00	3.69E+02
74851	ethylene	0.0636	1.0996						
50000	formaldehyde	0.0158	0.3607	6.00E-06	3.00E+00	9.48E-08	2.16E-06	1.50E-09	1.08E+00
78795	isoprene	0.0014	0.0172			0.00E+00	NA	0.00E+00	NA
98828	isopropylbenzene (cumene)	0.0000	0.0061			0.00E+00	0.00E+00	0.00E+00	0.00E+00
67561	methyl alcohol	0.0001	0.0421		4.00E+03	0.00E+00	NA	0.00E+00	NA
78933	methyl ethyl ketone (mek) (2-butanone)	0.0000	0.0073		1.00E+03	0.00E+00	0.00E+00	0.00E+00	7.32E+00
108383	m-xylene	0.0020	0.5474		7.00E+02	0.00E+00	NA	0.00E+00	NA
91203	naphthalene	0.0000	0.0160	3.40E-05	9.00E+00	8.80E-10	5.43E-07	2.28E-14	1.44E-01
110543	n-hexane	0.0009	0.1611		7.00E+03	0.00E+00	0.00E+00	0.00E+00	1.13E+03
95476	o-xylene	0.0007	0.1906		7.00E+02	0.00E+00	0.00E+00	0.00E+00	1.33E+02
123386	propionaldehyde	-	0.0160				0.00E+00		0.00E+00
115071	propylene	0.0017	0.6027		3.00E+03	0.00E+00	0.00E+00	0.00E+00	1.81E+03
100425	styrene	0.0001	0.0160		9.00E+02	0.00E+00	0.00E+00	0.00E+00	1.44E+01
108883	toluene	0.0032	0.8351		3.00E+02	0.00E+00	0.00E+00	0.00E+00	2.51E+02
Total		**0.1097**	**5.2275**			**1.86E-07**	**3.18E-05**	**1.57E-09**	**3.74E+03**

Notes:
1. Unit risk factor from Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, April 25, 2005.

APPENDIX J

SOURCE TREATMENT AND ASSUMPTIONS FOR AIR DISPERSION MODELING FOR NON-LOCOMOTIVE SOURCES

Appendix J

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources

As shown in Figure 3 emissions were allocated spatially throughout the Yard in the areas where each source type operates or is most likely to operate. Emissions from mobile sources, ramps and forklifts were simulated as a series of volume sources along their corresponding travel routes and work areas. Emissions are first allocated to the areas of the yard where specified activity occurs, and are then allocated uniformly to a series of sources within the defined areas. Depending on their magnitude and proximity to yard boundaries, idling emissions for heavy duty trucks may be treated as point sources rather than being included in the non-idling volume sources used to characterize moving vehicles

Assumptions used spatially to allocate emissions for each source group are shown in the Table below. See Figure 3 for the source locations. See Appendix A-4 for assumptions regarding the spatial allocation of locomotive emissions.

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources
Mira Loma Auto Facility

Source	Source Treatment	Assumptions for Spatial Allocation of Emissions
HHD Diesel-Fueled Trucks (idling)	Volume	Allocated truck idling emission evenly between the loading area and the gate.
HHD Diesel-Fueled Trucks (traveling)	Volume	Traveling emissions were distributed uniformly along the routes followed from the gate to the loading area.
Forklifts (low level)	Volume	Allocated all emissions to the area in and around the storage tracks.
Ramps (low level)	Volume	Allocated all emissions to the area in and around the vehicle unloading area.

APPENDIX K

SEASONAL AND DIURNAL ACTIVITY PROFILES

Appendix K

Development of Temporal Activity Profiles for the UPRR Mira Loma Auto Facility

Locomotive activity can vary by time of day and season. For each yard, the number of trains arriving and departing from the yard in each month and each hour of the day was tabulated and used to develop temporal activity profiles for modeling. The number of locomotives released from service facilities in each month was also tabulated. The AERMOD EMISFACT SEASHR option was used to adjust emission rates by season and hour of the day, and the EMISFACT SEASON option was used where only seasonal adjustments were applied. Where hour of day adjustments (but not seasonal) were applied, the EMISFACT HROFDY option was used.

Time of day profiles for train idling activity were developed assuming that departure events involved locomotive idling during the hour of departure and the two preceding hours, and that arrival events involved locomotive idling during the hour of arrival and the two hours following. Thus, the hourly activity adjustment factor for hour i is given by

$$\frac{\frac{1}{3}\cdot\sum_{j=i}^{i+2} NA(j) + \frac{1}{3}\cdot\sum_{j=i-2}^{i} ND(j)}{\sum_{j=1}^{24}(NA(j)+ND(j))},$$

where $NA(j)$ and $ND(j)$ are respectively the number of arriving and departing trains in hour j. These factors were applied to both idling on arriving and departing trains and idling in the service area (if applicable).

Similarly, time of day profiles for road power movements in the yard (arrivals, departures, and power moves) were developed without including arrivals in preceding hours and departures in subsequent hours. In this case, the hourly activity adjustment factor for hour i is given by

$$\frac{NA(i)+ND(i)}{\sum_{j=1}^{24}(NA(j)+ND(j))}.$$

Seasonal adjustment factors are calculated as the sum of trains arriving and departing in each three month season, divided by the total number of arrivals and departures for the year. The hourly adjustment factors for each season are simply the product of the seasonal adjustment factor and the 24 hourly adjustment factors.

For yards with heavy duty truck and cargo handling activities related to rail traffic, seasonal train activity adjustments were applied, but not hour of day adjustments. Temporal profiles for yard switching operations were based on hourly (but not seasonal) factors developed from the operating shifts for the individual yard switching jobs. In some cases, locomotive load testing diurnal profiles were developed based on the specific times of day when load testing is conducted.

Table K-1 lists the hourly activity factors derived for train movements, train idling, and heavy duty truck activity at the UPRR Mira Loma Facility. Separate temporal profiles are listed for day and night moving train emissions as different volume source parameters are used for day and night. Table K-2 lists the seasonal activity factors for train and heavy duty truck activity.

Table K-1. Hourly Activity Factors for the UPRR Mira Loma Facility

Hour	Train and Service Idling	Train Movements (Daytime)	Train Movements (Nighttime)	Heavy Duty Trucks
1	1.476	0.000	1.792	0.400
2	1.292	0.000	0.984	0.400
3	1.138	0.000	1.213	0.400
4	1.048	0.000	1.096	0.400
5	1.058	0.000	1.092	0.400
6	0.905	0.000	0.910	0.400
7	0.868	0.770	0.000	1.600
8	0.781	0.583	0.000	1.600
9	0.788	0.751	0.000	1.600
10	0.714	0.569	0.000	1.600
11	0.717	0.798	0.000	1.600
12	0.795	0.872	0.000	1.600
13	0.810	0.760	0.000	1.600
14	0.854	1.003	0.000	1.600
15	0.782	0.812	0.000	1.600
16	0.851	0.681	0.000	1.600
17	0.806	0.658	0.000	1.600
18	1.022	1.040	0.000	1.600
19	0.986	0.000	0.747	0.400
20	1.092	0.000	1.428	0.400
21	0.913	0.000	0.882	0.400
22	1.247	0.000	0.966	0.400
23	1.401	0.000	0.956	0.400
24	1.656	0.000	2.636	0.400

Table K-2. Seasonal Activity Factors for the UPRR Mira Loma Facility

Activity Type	Winter	Spring	Summer	Fall
Trains and Heavy Duty Trucks	0.963	1.074	0.998	0.966

APPENDIX L

SELECTION OF POPULATION FOR THE URBAN OPTION INPUT IN AERMOD AIR DISPERSION MODELING ANALYSIS

Appendix L

Selection of Population for the Urban Option Input in AERMOD Air Dispersion Modeling Analysis

Urban heat islands and the thermal domes generated by them extend over an entire urbanized area[1]. Hot spots within the urban heat island are associated with roads and roofs, which surround each Union Pacific (UP) rail yard in high density. Following guidance cited by the ARB ("*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source.*"), it is the entire metropolitan area that contributes to the urban heat island plume affecting the rail yard. For metropolitan areas containing substantial amounts of open water, the area of water should not be included.

To simulate the effect of the urban heat island on turbulence in the boundary layer, especially at night, when the effect is substantial, AERMOD adjusts the height of the nighttime urban boundary layer for the heat flux emitted into the boundary layer by the urban surface, which is warmer than surrounding rural areas[2,3]. The difference between the urban and rural boundary layer temperatures is proportional to the maximum temperature difference of 12 Celsius degrees observed in a study of several Canadian cities, and directly related to the logarithm of the ratio of the urban population to a reference population of 2,000,000 (i.e., Montreal, the Canadian city with the maximum urban-rural temperature difference)[4].

The adjusted height of the nocturnal urban boundary layer is proportional to the one-fourth power of the ratio of the population of the city of interest to the reference population, based on the observation that the convective boundary layer depth is proportional to the square root of the city size, and city size is roughly proportional to the square root of its population, assuming constant population density[5]. Regardless of wind direction during any specific hour used by AERMOD, it is the entire metropolitan area, minus bodies of water, which moves additional heat flux into the atmosphere and affects its dispersive properties, not just the 400 km^2 area of the air dispersion modeling domain that surrounds the each rail yard, which was chosen purely for modeling convenience.

Continuing to follow the guidance cited by the ARB ("*If this approach results in the identification of clearly defined MSAs, then census data may be used as above to determine the appropriate population for input to AERMOD*"), the population of each Metropolitan Statistical Area is being used in the modeling run for each rail yard.

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[1] USEPA. *Thermally-Sensed Image of Houston,* http://www.epa.gov/heatisland/pilot/houston_thermal.htm, included in Heat Island Effect website, http://www.epa.gov/heatisland/about/index.html, accessed November 8, 2006.
[2] USEPA. *AERMOD: Description of Model Formulation,* Section 5.8 – Adjustments for the Urban Boundary Layer, pages 66-67, EPA-454/R-03-004, September 2004, accessed at http://www.epa.gov/scram001/7thconf/aermod/aermod_mfd.pdf on November 9,
[3] Oke, T.R. *City Size and the Urban Heat Island,* Atmospheric Environment, Volume 7, pp. 769-779, 1973.
[4] Ibid for References 3 and 4.
[5] Ibid.

APPENDIX M

DEMOGRAPHIC DATA

Appendix M

Population Shape Files for UPRR Rail Yards

The accompanying shape files include census boundaries as polygons and the corresponding residential populations from the 2000 U.S. Census. Separate shape files are included at the tract, block group, and block levels. The primary ID for each polygon begins with *ssccctttttt*, where *ss* is the FIPS state code (06 for California), *cc* is the county code, and *tttttt* is the tract code. The primary IDs for block groups have a single additional digit which is the block group number within each tract. Those for blocks have four additional digits identifying the block number. The population for each polygon are included as both the secondary ID and as attribute 1. Polygon coordinates are UTM zone 10 (Oakland and Stockton) or 11 (southern California yards), NAD83, in meters. The files contain entire tracts, block groups, or blocks that are completely contained within a specified area. For all yards except Stockton, the area included extends 10 kilometers beyond the 20 x 20 kilometer modeling domains. For Stockton, this area was extended to 20 kilometers beyond the modeling domain boundaries to avoid excluding some very large blocks.

In merging the population data[1] with the corresponding boundaries[2], it was noted that at all locations, there are defined census areas (primarily blocks, but in some cases block groups and tracts) for which there are no population records listed in the population files. Overlaying these boundaries on georeferenced aerial photos indicates that these are areas that likely have no residential populations (e.g., industrial areas and parks). The defined areas without population data have been excluded from these files. Areas with an identified population of zero have been included. It was also observed that some blocks, block groups and tracts with residential populations cover both residential areas and significant portions of the rail yards themselves. For this reason, any analysis of population exposures based on dispersion modeling should exclude receptors that are within the yard boundaries or within 20 meters of any modeled emission source locations.

To facilitate the exclusion of non-representative receptors, separate shape files have been generated that define the area within 20 meters of the yard boundaries for each yard. These files are also included with the accompanying population files. It should also be noted that the spatial extent of individual polygons can vary widely, even within the same type. For example, single blocks may be as small as 20 meters or as large as 10,000 meters or more in length. To estimate populations contained within specific areas, it may prove most useful to generate populations on a regular grid (e.g., 250 x 250 m cells) rather than attempting to process irregularly shaped polygons.

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[1] Population data were extracted from the *Census 2000 Summary File 1* DVD, issued by the U.S. Department of Commerce, September 2001.

[2] Boundaries were extracted from ESRI shapefiles (*.shp) created from the U.S. Census TIGER Line Files downloaded from ESRI (*http://arcdata.esri.com/data/tiger2000/tiger_download.cfm*).